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ABSTRACT

To contribute to an understanding of the elements of good air traffic controller communication with the objective of providing recommendations to improve controller communication training, two studies analyzed team communication, ground-air communication, and ground-line communication. The simulated and live traffic analyses examined established and new controller teams drawn from three different experience levels. The design included team types made up of expert and intermediate controllers who had worked together at their control centers; and team types made up of experts, intermediates, and novices who had not worked together previously. A total of 24 participants in the Simulated Traffic Communication Analyses comprised of experts, intermediates and novices worked in teams of two controllers each on a total of six simulator problems over a period of 2 days. A total of 14 participants worked in 2-person teams of radar controller and radar associate controller in the live traffic analyses. Results of the two studies suggested that: (1) advanced communication training for en route traffic controllers should be embedded in the relevant training on those tasks that are primarily cognitive and operational; (2) a new emphasis should be placed on the functions of different types of communication within controller teams and between controller teams and other sectors and facilities; (3) the goal of en route controller communication training should be to provide controllers with an extensive repertoire of communication skills and techniques that the controllers can use on a selective basis to accomplish specific tasks; and (4) developmental controllers should be trained in the skills, and choices of communication strategies, that were demonstrated by the controllers in the top rated teams in this study. (Thirty tables of data and 27 figures are included.) (PRA)

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ANALYSIS OF CONTROLLER COMMUNICATION IN EN ROUTE AIR TRAFFIC CONTROL

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Abstract

This report provides a description and analysis of en route air traffic controller communication based on analyses of team communication, ground-air communication, and ground-line communication. These analyses contribute to an understanding of the elements of good controller communication with the objective of providing a set of recommendations to improve controller communication training.

Communication is a major function of the en route air traffic control job, having a substantial effect on controller performance. Controllers communicate with pilots in a highly proceduralized way, and this form of communication has been the subject of a number of research efforts. Controllers communicate with each other at the team level, and this form of communication is the least proceduralized and has not been carefully analyzed. Team communication is a significant component of team performance and should be emphasized in team training. Therefore, this study emphasized analyses of team communication: the speech turns between the controller and the associate controller.

These analyses were based on data gathered in two different environments. The first set of analyses, Simulated Traffic, was based on data collected from participants controlling simulated traffic in the laboratory environment at the Federal Aviation Administration Radar Training Facility. The second set of analyses, Live Traffic, was based on data from controllers managing live traffic. This analysis of speech communication, although behavioral in nature, was unique in that speech turns were analyzed in relation to the performance of various cognitive tasks. Effective team communication was characterized by its emphasis upon performing two key cognitive tasks: maintaining situation awareness and planning.

The findings are integrated into a model of team communication resulting in training recommendations to support the Federal Aviation Administration's new training curriculum. The results also suggest important implications for training team communication skills in other work time-constrained multi-tasking environments.

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I. INTRODUCTION

INTRODUCTION

OVERVIEW

This report provides an initial description of en route air traffic controller communication based on analyses of team communication, ground-air communication, and ground-line communication. These analyses contribute to an understanding of the elements of good controller communication with the objective of providing a set of recommendations to improve controller communication training.

Communication is a major function of the en route air traffic control job, having a substantial effect on controller performance. Controllers communicate with pilots in a highly proceduralized way, and this form of communication has been the subject of a number of research efforts (Loftus, Dark, & Williams, 1979; Morrow, Lee, & Rodvold, 1990; and Grayson & Billings, 1981). Air traffic controllers also communicate with controllers of other sectors, and this process, though proceduralized, has been less researched. Finally, controllers communicate with each other at the team level, and this form of communication is the least proceduralized and has not been carefully analyzed. There are indications from related research areas, such as Cockpit Resource Management (CRM), that team communication may be a significant component of team performance and should be emphasized in team training. Therefore, this study emphasized analyses of team communication.

These analyses were based on data gathered in two different environments. The first set of analyses, Simulated Traffic, was based on data collected from participants controlling simulated traffic in the laboratory environment at the Federal Aviation Administration (FAA) Radar Training Facility. The second set of analyses, Live Traffic, was based on data from controllers managing live traffic at two Air Route Traffic Control Centers (ARTCC's). The methods and results for these two sets of analyses are reported separately, and the findings are then integrated in the Summary and Training Implications sections of the report.

This study used an inductive approach to look at communication frequencies for different types of controller teams. The simulated traffic analyses examined established and new controller teams drawn from three different experience levels. The design included a total of eight team types: three established team types made up of expert and intermediate controllers who had worked together at their control centers; and five team types made up of experts, intermediates, and novices who had not worked together previously. Because there is little existing research on en route controller communication, no specific hypotheses were proposed for this study, but a review of related research indicated several approaches and communication patterns that might be significant in the current research effort.

RELATED RESEARCH

Kanki, Lozito, and Foushee (1989) found that in low-error aircraft flightcrew teams, Captains gave more commands than average and First Officers gave more acknowledgments than average. In general, the good crews had a high degree of communication homogeneity, indicating that they had established a predictable pattern of communication. These findings led to the conclusion that when flightcrew communication predictability increased, coordination was more reliable and, consequently, more likely to succeed. In contrast, the high-error crews had greater diversity in their communication behavior. Overall, these crews had fewer commands and more questions. The researchers concluded that the high-error crews showed a lack of standard solutions and established conventions.

Helmreich, Chidester, Foushee, Gregorich, and Wilhelm (1989) reported a pattern that they observed in the ratings of a composite measure of CRM effectiveness. The flightcrew members rated themselves significantly more favorably than did the expert observers. One explanation for this pattern is that the expert observers had more experience at rating CRM performance, whereas the crew members had a more limited frame of reference. Although the present analyses did not use the same rating instrument for participants and expert observers, it is still valuable to compare the subjective and objective measures used to assess controller communication.

In another set of CRM results, Foushee, Luaber, Baetge, and Acomb (1986) obtained a number of findings relevant to the current analyses. Regarding flightcrew performance measures, these researchers found more significant differences between crews when they were working under conditions of high workload. This finding suggested that controller communication should be analyzed under varying workload conditions. The flightcrew communication analyses of Foushee et al. (1986) have isolated a number of communication patterns associated with either better performing or more established flightcrews. The good teams exchanged more commands, with the Captains giving more commands than the First Officers. This trend was more significant under conditions of heavier workloads. In addition, First Officers were more likely to use commands when they were more familiar with the Captain. Finally, flightcrews that previously had flown together exchanged a greater number of statements of intent, suggestions, disagreements, and acknowledgments. These results suggest that the more established flightcrews develop patterns of communication where the Captains offer more suggestions to the First Officers. First Officers also express more statements of intent and are more likely to use commands as well as to note disagreement.

Using communication-coding techniques similar to the flightcrew studies, Morrow et al. (1990) provided an overview of ground-air communication. These researchers were studying ground-air communication from terminal approach and departure sectors, rather than from the en route sectors that are the subject of the present study. The data from Morrow et al. (1990) document routine communication as well as communication problems such as inaccuracies, procedural deviations, and nonroutine transactions.

RELATED RESEARCH (Continued)

Controller communication, whether communicating with another controller or a pilot, can be analyzed at a number of different levels: speech acts, speech turns, and transactions (Kanki et al., 1989; Morrow et al., 1990). At the most basic level, controller communication is made up of utterances or speech acts, each with a specific function. At the next level, a speech turn is made up of one or more sequential speech acts spoken by one individual to another. These communication turns are generally bounded by pauses, interruptions, or replies. At an even higher level, a communication transaction is made up of one or more related turns in which speakers exchange information.

Morrow et al. (1990) found that routine communication transactions for the approach and departure sectors were generally made up of one controller turn and one pilot turn. Controller turns tended to have more speech acts (average = 3.5) as compared with pilot turns (average = 2 speech acts per turn). An analysis of communication problems revealed that controllers made few procedural deviations (only about 4 percent of their turns), and, in most cases, these deviations occurred when the controller did not identify himself or the pilot being addressed. The nonroutine transactions, caused by misunderstandings or uncertainty, made up about 10 percent of all transactions. These nonroutine transactions were less standard and more likely to include full sentences as well as pronouns that could lead to ambiguity. This summary of approach and departure sector communication suggested that it might be useful, in the current project, to look specifically at the nonroutine communications of en route controllers.

In the present study, the simulated traffic data analyses focused on links between team performance and communication patterns at the speech turn level, whereas the live traffic data were analyzed at the speech act level. Therefore, the simulated traffic data analyses considered turns as individual entities rather than as interactive parts of a transaction. This level of analysis of the simulated traffic data was selected for reasons of efficiency to provide a general description of controller communication based on a relatively large amount of data. The live traffic analyses involved a more detailed investigation of a smaller data sample.

Simulated Traffic Analyses: Based on the results of previous research discussed above, the simulated traffic effort included analyses of the following relationships:

- Differences among more-experienced and less-experienced controller teams in the frequency of use of specific communication categories, including commands, acknowledgments, suggestions, statements of intent, and disagreements.

- Differences among established and new controller teams in the frequency of use of specific communication categories, including commands, acknowledgments, suggestions, statements of intent, and disagreements.

- Differences in communication frequencies for the various communication categories between the radar controller (R-side) and the radar associate controller (D-side).

RELATED RESEARCH (Continued)

- Differences between higher-rated and lower-rated teams in their usage of commands, acknowledgments, and other relevant communication categories.
- Differences in controller communication between conditions of moderate and heavy workload.
- Differences among team types on nonroutine communication.

Live Traffic Analyses: The live traffic analyses utilized the results of recent research on the cognitive functioning of en route air traffic controllers by linking the present controller communication data to the data developed as part of the cognitive task analysis of en route air traffic control (Human Technology, 1990, 1991).

The cognitive analysis research describes how an expert controller views the air traffic control situation (captured in the mental model) and how goals are accomplished by actions (described in the tasks, task triggers, task subgoals, and controller strategies).

Communicating parties need to understand each other's goals and motives and determine how to integrate them with their own. It is assumed that controller communication is essentially cooperative in nature, a special form of interaction in which the cooperating agents share goals and act in concert over an extended period of time.

Current research on interaction between cooperating agents (Suchman, 1985; Kanki et al., 1989) suggests that communication should be examined with respect to the situation or context in which the communication occurs. In the live traffic analyses, communication was related to the context, based on tasks from the cognitive analysis of en route air traffic control. The cognitive analysis task categories provide a means to categorize a given communication unit based on the appropriate air traffic control task, placing the communication within the context of the subgoals that define how the controller team will accomplish the task.

The analysis of the live traffic data explored the following relationships:

- Differences between radar controllers and radar associate controllers in the frequency of use of specific communication categories and controller task categories.
- Differences in frequency of communication categories and controller task categories in the controller side of ground-air and ground-line communications.

II. METHODS: SIMULATED TRAFFIC

PARTICIPANTS

A total of 24 participants in the Simulated Traffic Communication Analyses comprised the following three groups: experts, intermediates, and novices. The experts included 8 controllers with 6 or more years of full performance level (FPL) experience (mean years controller experience = 19.56, standard deviation = 9.28; mean years FPL = 17.25, standard deviation = 9.57). The intermediates included 8 controllers with 1.5 or fewer years of FPL experience (mean years controller experience = 4.00, standard deviation = 1.28; mean years FPL = 0.86, standard deviation = 0.29). The novices included 8 controllers with no FPL experience (mean years controller experience = 1.75, standard deviation = 0.60).

Participants were drawn from ARTCC's in the continental United States.

The above three groups of participants were arranged into the following eight team types:

Expert/expert, established teams (EEE)
Expert/expert, new teams (EEN)
Expert/intermediate, established teams (EIE)
Expert/intermediate, new teams (EIN)
Intermediate/intermediate, established teams (IIE)
Intermediate/intermediate, new teams (IIN)
Novice/novice, new teams (NNE)
Novice/novice, second new teams (NNN)

Established teams were composed of controllers from the same ARTCC. The expert/expert, established teams had an average of 15.75 years of FPL experience, with one team having a week and the other team having more than two weeks since they last worked together. The expert/intermediate, established teams had an average of 9.76 years of FPL experience, and of the four teams, one had about a week and two teams had more than two weeks since they had worked together. The fourth expert/intermediate team, although made up of controllers from the same center, had not worked together. Finally, the intermediate/intermediate established teams had .96 years of FPL experience, and it had been about one week since both teams had last worked together.

PROCEDURES

Participants worked in teams of two controllers each on a total of six simulator problems over a period of 2 days. At the beginning of the data collection session, participants were given an introduction to the communication analysis study followed by a presentation on the sector in Aero Center that would be under their control (see Table 2.1). The participants were then divided into established teams (except for the novices) made up of a radar controller (R-side) and a radar associate controller (D-side). Each team was given two or three practice control problems to familiarize them with Aero Center and the simulator equipment.

PROCEDURES (Continued)

Before starting the simulator problems, participants were assured that all the data were being gathered anonymously and that the results of their work were confidential. They were informed that this was not an evaluation, but an exercise to gather data on how controllers communicate as a team. Finally, the participants were told that if at any time they did not wish to continue, they were to say so, and the problem would be stopped.

Table 2.1. Typical Two-Day Schedule for the Simulator Problems

	Day One	Day Two
	Established Team	**Established Team**
Morning Schedule	Introduction to the Communication Analysis Presentation on Aero Center Two or three Practice Problems Break for Lunch	Third Simulator Problem Subjective Questionnaires Break Fourth Simulator Problem Subjective Questionnaires Break for Lunch
	Established Team	**New Team**
Afternoon Schedule	First Simulator Problem Subjective Questionnaires Break Second Simulator Problem Subjective Questionnaires	Fifth Simulator Problem Subjective Questionnaires Break Sixth Simulator Problem Subjective Questionnaires Final Debriefing

After participants had a chance to ask questions, the first 30-minute simulator problem was started, and the entire session was recorded on videotape and three separate audio tracks. Within a team, individuals were allowed to select whether they worked the R-side or D-side, and they would normally switch positions after each problem. At the end of each simulator problem, team members were given a set of subjective questionnaires to complete (see Appendix A to this report) followed by a break. At the end of the fourth problem, new teams were formed by matching the controllers with partners they had never worked with from another ARTCC.

SIMULATOR PROBLEMS

Ten simulator problems were designed to elicit a broad range of communication behavior from the controlling teams. The problems included a number of ghost pilot prompts for requests such as for specific altitudes or vectors. In addition, many of the problems had specific requests or queries from adjoining sectors. The problems were developed by en route training personnel at the FAA Radar Training Facility and were evaluated for level of workload. Based on the evaluation, three of the problems were identified as presenting a moderate level of workload to a team of controllers not familiar with Aero Center, and three were identified as presenting a heavy workload to teams unfamiliar with Aero Center. The remaining four problems were used as practice for Aero Center familiarization purposes.

The six test problems each lasted 30 minutes and required that the R-side and D-side controllers perform a representative range of controller tasks. The three moderate workload problems had an average of 26 planes in each scenario with an average of 8 ghost pilot requests per problem. The heavy workload problems had an average of 31 planes in each scenario with an average of 11 ghost pilot prompts for requests or incorrect readbacks. One of the heavy workload problems included a MODE C failure, and a second problem in this category contained a beacon equipment failure.

CODING PROCEDURES

Controller communications from each session were transcribed into three transcripts: one for team communication, one for R-side radio communication (ground-air), and one for D-side ground-line communication. These transcripts were subdivided into their relevant speech turns, and each turn was then coded, using the appropriate coding scheme. The team communication coding scheme has 15 categories as defined in Table 2.2. This coding scheme is a modification of the 18 communication categories in Foushee et al. (1986). The ground-air communication coding scheme, defined in Table 2.3, has nine categories and is a modification of Foushee et al. (1986) and Morrow et al. (1990). The ground-line coding scheme, defined in Table 2.4, contains the same categories as the ground-air coding scheme plus three additional categories unique to intersector communication.

CODING PROCEDURES (Continued)

Two coders were trained in the meaning and application of these codes to the three types of controller communication. At first, the coders practiced with sample transcripts of both simulated and live traffic communication. A set of rules was developed to further refine the coding procedure and to clarify the use of specific codes (see Appendix A). Once the three sets of codes were mastered, the coders were given a set of transcripts from one of the actual simulator sessions, and their codings were used to calculate intercoder reliability. The first pass resulted in 64 percent agreement on team communication coding, 88 percent agreement on ground-air communication, and 87 percent agreement on ground-line communication. The ground-air and ground-line intercoder reliability was deemed acceptable, but team communication coding reliability needed improvement. Additional rules were developed to clarify the definitions of the codes that accounted for most of the disagreement. Particular emphasis was placed on clarifying "answer supplying information," "agreement," and "response uncertainty." With the refined set of rules and additional practice, a new intercoder reliability of 93 percent was achieved on the team communication coding.

CODING PROCEDURES (Continued)

Table 2.2. The Scheme Used To Code Team Communication Speech Turns

Team Communication Coding Scheme	
Courtesy Comment:	A speech turn aimed at building a positive relationship by showing courtesy (e.g., thank you) or appreciation (e.g., nice job).
Command:	A specific assignment of responsibility in the form of a declarative statement or a request for action.
Inquiry—Situational:	A request for factual information relating to past or present tasks; not a request for action.
Inquiry—Intent:	A request for information about another's intended action. Included inquiries about present and future actions, but not about previous actions.
Observation:	A remark aimed at recognizing or noting a fact or occurrence relating to the task.
Suggestion:	Suggesting a course of action directly as a recommendation.
Statement of Intent:	An announcement of intended action by the speaker. Includes statements referring to present and future actions, but not to previous actions.
Acknowledgment:	Verbally makes known that a prior speech turn was heard; does not supply additional information; does not evaluate or correct a prior speech turn; does not express courtesy.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment, agreement, or disagreement.
Agreement:	A response indicating concurrence with a previous speech turn; a positive evaluation of a prior speech turn.
Disagreement:	A response not in concurrence with a previous speech turn; a negative evaluation of a prior speech turn.
Response Correcting Presented Information:	A response that questions the accuracy of, or corrects, a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard or not understood.
Non-Task-Related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

CODING PROCEDURES (Continued)

Table 2.3. The Scheme Used To Code Ground-Air Communication Speech Turns

Ground-Air Coding Scheme	
Command:	A specific assignment of responsibility in the form of a declarative statement.
Inquiry:	A request for factual information relating to the task; not a request for action.
Report:	Self-initiated, the providing of task-related information.
Acknowledgment:	Verbally makes known a prior speech turn was heard; does not supply additional information or correct or evaluate a previous speech turn.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment.
Response Correcting Presented Information:	A response that questions the accuracy of, or corrects, a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard or not understood.
Non-Task-Related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

CODING PROCEDURES (Continued)

Table 2.4. The Scheme Used To Code Ground-Line Communication Speech Turns

Ground-Line Coding Scheme	
Command:	A specific assignment of responsibility in the form of a declarative statement or a request for action that is not a handoff or a pointout.
Verbal Handoff:	A verbal request to transfer radar identification and radio communication to another sector.
Pointout:	A verbal request to transfer radar identification to another sector while maintaining radio contact.
Inquiry:	A request for factual information relating to the task; not a request for action.
Report:	Self-initiated, the providing of task-related information.
Request Permission:	A speech turn asking permission to take an action oneself.
Acknowledgment:	Verbally makes known a prior speech turn was heard; does not supply additional information or correct or evaluate a previous speech turn.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment.
Response Correcting Presented Information:	A response that questions the accuracy of, or corrects, a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard or not understood.
Non-Task-Related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

MEASUREMENTS OF PERFORMANCE

Four sets of measures were developed to evaluate both individual and team performance (see Appendix A). The first set was based on expert observer ratings and included ratings of team operation as well as team and individual communication performance. The second set of measures was based on communication inaccuracies, both ground-air and ground-line inaccuracies. The third set was based on nonroutine communications arising from specific types of communication problems. The last set of measures included the subjective ratings of team members. Each of these sets of measures is described below.

Expert Observer Ratings: Two instructors from the FAA Radar Training Facility were used as expert observers during the 72 simulator problem sessions. One expert would directly observe each session and at the end of the 30-minute problem would rate the team in four different categories. Each of these categories was made up of several dimensions, and each dimension was rated on a seven-point Likert-type scale. The first category, Overall Team Operation, includes the following four ratings:

Managing separation
Managing traffic flow
Providing service to aircraft
Overall efficiency

These four ratings were combined to generate an overall measure of the team performance.

The second category of expert observer ratings, Team Communication, concentrated on the following aspects of team communication:

Verbal communication
Nonverbal communication
Written communication (Strip Marking)

The third category of expert observer ratings, Communicating With Pilots, emphasized the following elements of R-side radio communication:

Timeliness
Efficiency
Phraseology

The fourth category of expert observer ratings, Communicating With Other Sectors, was based on the following three ratings of ground-line communication:

Timeliness
Efficiency
Phraseology

MEASUREMENTS OF PERFORMANCE (Continued)

Communication Inaccuracies: During each session, an expert observer kept a tally of ground-air and ground-line inaccuracies. The expert observers looked for the following types of ground-air inaccuracies:

- Center/Sector Identification
- Acknowledgment
- Command
- Report
- Other Controller Inaccuracy
- Missed Incorrect Callsign
- Missed Incorrect Readback
- Missed Lack of/Incorrect Acknowledgment
- Missed Other Pilot Inaccuracy

The expert observers also were tallying the following ground-line inaccuracies:

- Center/Sector Identification
- Addressee Callsign
- Handoff
- Pointout
- Command/Other Action Request
- Other Controller Inaccuracy
- Missed Incorrect Callsign
- Missed Incorrect Readback
- Missed Incorrect Acknowledgment
- Other Missed Inaccuracy

Nonroutine Communication: The nonroutine communication measures were derived from the coding of the session transcripts. Team, ground-air, and ground-line communication transcripts were reviewed for the following two communication categories:

- Response Correcting Presented Information
- Response Uncertainty

In addition, the team communication transcripts were reviewed for "Disagreement." The composite nonroutine communication score was the total of these three communication categories for each session.

MEASUREMENTS OF PERFORMANCE (Continued)

Subjective Team Evaluations: The final set of performance measures was based on the subjective ratings of the team members following each simulator problem session. The subjective team communication ratings form contained a number of categories under teamwork behaviors. Each of these categories was made up of several dimensions, and each dimension was rated on an 8-point Likert-type scale defined as follows: 0 = don't know, 2.5 = not at all characteristic, 4.5 = moderately characteristic, and 7 = highly characteristic. The following categories were utilized:

Situational Awareness
Assertiveness
Adaptability/Flexibility
Teamwork
Communication
Decisionmaking

Additional ratings were obtained for air traffic control task and team characteristics, overall workload, and team effectiveness.

ANALYSIS

There were 72 simulator problem sessions. For each session, the transcriptions of team communication, R-side radio communication, and D-side ground-line communication were subdivided into their relevant speech turns. Within each transcript, each speech turn was coded using the appropriate coding scheme (see Appendixes A, B, and C).

Overall Communication Analysis

The average number of speech turns was calculated for the relevant cells in the matrix shown in Table 2.5 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Overall Communication Analysis (Continued)

Table 2.5. Matrix for the Overall Communication Analysis

	R-Side	D-Side	Total
Team Communication On Task			
Team Communication Not on Task			
Team Communication Noncodable			
Ground-Air Communication			
Ground-Air Noncodable			
Ground-Line Communication			
Ground-Line Noncodable			

Team Communication Analysis

The total number of speech turns and the average number of speech turns were calculated for the relevant cells in the matrix shown in Table 2.6 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Team Communication Analysis (Continued)

Table 2.6. Matrix for the Team Communication Analysis

	R-Side	D-Side	Total
Courtesy Comment			
Command			
Inquiry—Situation			
Inquiry—Intent			
Observation			
Suggestion			
Statement of Intent			
Acknowledgment			
Answer Supplying Information			
Agreement			
Disagreement			
Response Correcting Presented Information			
Response Uncertainty			
Non-Task-Related Comment			
Noncodable			

Team Communication Analysis (Continued)

Three additional analyses were conducted on team communication to explore differences between the better and the less-well performing teams. First, the sessions that had the highest expert ratings for overall team operation (top 25 percent) were compared with the sessions that had the lowest expert ratings (bottom 25 percent) looking at both heavy and moderate workload conditions. Second, the sessions with the fewest inaccuracies were compared with the sessions with the most inaccuracies for both heavy and moderate workload conditions. Finally, the sessions with the fewest nonroutine communications were compared with the sessions with the most nonroutine communications for both heavy and moderate workload conditions.

Ground-Air Communication Analysis

The total number of speech turns, the average number of speech turns, and the relative percentages were calculated for the relevant cells in the matrix shown in Table 2.7 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Table 2.7. Matrix for the Ground-Air Analysis

	R-Side
Command	
Inquiry	
Report	
Acknowledgment	
Answer Supplying Information	
Response Correcting Presented Information	
Response Uncertainty	
Non-Task-Related Comment	
Noncodable	

Ground-Air Communication Analysis (Continued)

Three additional analyses were conducted on ground-air communication to explore differences between the better and the less-well performing teams. First, the sessions that had the highest expert ratings for overall team operation (top 25 percent) were compared with the sessions that had the lowest expert ratings (bottom 25 percent) looking at both heavy and moderate workload conditions. Second, the sessions with the fewest inaccuracies were compared with the sessions with the most inaccuracies for both heavy and moderate workload conditions. Finally, the sessions with the fewest nonroutine communications were compared with the sessions with the most nonroutine communications for both heavy and moderate workload conditions.

Ground-Line Communication Analysis

The total number of speech turns and the average number of speech turns were calculated for the relevant cells in the matrix shown in Table 2.8 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Ground-Line Communication Analysis (Continued)

Table 2.8. Matrix for the Ground-Line Analysis

	R-Side	D-Side	Total
Command			
Verbal Handoff			
Pointout			
Inquiry			
Report			
Request Permission			
Acknowledgment			
Answer Supplying Information			
Response Correcting Presented Information			
Response Uncertainty			
Non-Task-Related Comment			
Noncodable			

Three additional analyses were conducted on ground-line communication to explore differences between the better and less-well performing teams. First, the sessions that had the highest expert ratings for overall team operation (top 25 percent) were compared with the sessions that had the lowest expert ratings (bottom 25 percent) looking at both heavy and moderate workload conditions. Second, the sessions with the fewest inaccuracies were compared with the sessions with the most inaccuracies for both heavy and moderate workload conditions. Finally, the sessions with the fewest nonroutine communications were compared with the sessions with the most nonroutine communications for both heavy and moderate workload conditions.

Nonroutine Communication Analysis

The total number of nonroutine communications and the average number of nonroutine communications were calculated for the relevant cells in the matrix shown in Table 2.9 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Understanding problems were defined as speech turns that were coded as "response uncertainty." Information problems were defined as speech turns that were coded as either "response correcting presented information" or "disagreement."

Table 2.9. Matrix for the Nonroutine Communication Analysis

	Team	Ground-Air	Ground-Line	Combined
Understanding Problem				
Information Problem				
Total Problems				

In addition, team, ground-air, and ground-line nonroutine communications for top and bottom performing teams were reviewed to isolate the relevant characteristics of the top performing teams.

Inaccuracies Analysis

The total number of inaccuracies and the average number of inaccuracies were calculated for the relevant cells in the matrix shown in Table 2.10 across the eight team types for moderate workload, heavy workload, and the average of the two workload conditions.

Table 2.10. Matrix for the Inaccuracies Analysis

	R-Side	D-Side	Total
Ground-Air Inaccuracies			
Ground-Line Inaccuracies			
Total Inaccuracies			

Correlations Between Communication Measures and Performance Measures

Correlations were calculated to identify those objective and subjective measures of communication that have relationships with the three primary performance measures. First, correlations were calculated between expert observer ratings of overall team operation and the objective coding categories, subjective ratings, and participant demographic data. Second, correlations were calculated between the total number of ground-air plus ground-line inaccuracies and the objective coding categories and subjective ratings. Finally, correlations were calculated between total number of nonroutine communications and the objective coding categories and subjective ratings.

III. RESULTS: SIMULATED TRAFFIC

RESULTS: SIMULATED TRAFFIC

INTRODUCTION

Due to the large amount of data collected for the simulated traffic analyses and the large number of statistical tests conducted on that data, this section of the report presents only the highlights of the data analysis results. More complete data, and full documentation of all statistical tests, can be found in the appendixes to this report.

OVERALL COMMUNICATION ANALYSIS

The overall communication analysis was conducted to provide a summary of the three types of communication across all eight team types. Table 3.1 summarizes the average (mean) number of speech turns for each of the established team types. These three established team types represent controllers who have worked together before and are likely to have developed better team coordination. The remaining five new team types (see Table 3.2) represent controllers who have not worked together.

Table 3.1. Mean Number of Speech Turns per Session for Established Teams

	Expert/Expert Est.			Expert/Int. Est.			Int./Int. Est		
	R-Side	D-Side	Total	R-Side	D-Side	Total	R-Side	D-Side	Total
Team Comm. On-Task	58	62	120	57	61	118	62	67	129
TC Non-Task-Related	18	20	38	7.6	6.4	14	7	6.7	13.7
TC Noncodable	5.9	5.6	11.5	4.3	3.4	7.7	1.9	1.4	3.3
Ground-Air Comm.	82	0	82	91	0	91	89	0	89
GA Noncodable	0.3	0	0.3	0.3	0	0.3	0	0	0
Ground-Line Comm.	0.3	30	30.3	0.1	38	38.1	0	37	37
GL Noncodable	0	0.8	0.8	0	0.3	0.3	0	0.5	0.5
Total	165	118	283	160	109	269	160	113	273

OVERALL COMMUNICATION ANALYSIS (Continued)

A comparison of the totals across all team types shows that the different team types used roughly equivalent numbers of speech turns per session with the expert/expert teams (both established and new) using slightly more speech turns than the other team types. In addition, the R-side controllers used consistently more speech turns than the D-side controllers. A closer examination of Tables 3.1 and 3.2 shows that the main reason for this difference is that the R-side controllers make substantially more ground-air communications compared with the D-side controllers' ground-line speech turns. At this general level, several speech turn frequencies help to characterize controller communication. The R-side and D-side controllers make approximately the same number of team communication speech turns, but the R-side controller has more turns overall because of the substantially larger number of ground-air speech turns. At this general level, there do not appear to be any major differences in total numbers of speech turns among the different team types.

Statistical tests (Analyses of Variance or ANOVA's) were conducted for the following three types of team communication: on-task, non-task-related, and noncodable. In the three-way ANOVA's, the three factors were team type (all eight types), controller side (R-side and D-side), and workload (moderate or heavy). The ANOVA for on-task communication (i.e., the combination of the 13 team speech turn categories) showed no significant differences, indicating that the various team types did not differ significantly in their total amount of task-related communication. The analysis of non-task-related comments showed a significant main effect for team type ($F = 23.034$, $df = 7, 112$, $p < .05$). A Duncan New Multiple Range test for multiple comparisons applied to the non-task-related means showed significant differences between 14 pairs of means. The general trend was for the more experienced teams to make significantly more non-task-related comments than the novice teams. The means for the expert/expert established (EEE) teams and the expert/expert new (EEN) teams were significantly larger than those of the other teams. The experts made more non-task-related comments than any of the other team types. This category of comments included general non-task-related statements, jokes, and comments about the equipment and sector peculiarities.

The team communication ANOVA for noncodable turns did not have a significant main effect for team type, but did have a significant main effect for controller side. The R-side controllers had significantly more noncodable speech turns (mean = 4.804, standard deviation = 5.058) than did the D-side controllers (mean = 3.186, standard deviation = 3.023). Many of the noncodable speech turns reflect the times that the controller was speaking to himself or herself, and the R-side controller was more likely to manifest this type of behavior.

OVERALL COMMUNICATION ANALYSIS (Continued)

Table 3.2. Mean Number of Speech Turns per Session for New Teams

	Expert/Expert New			Expert/Int. New			Int./Int. New		
	R-Side	D-Side	Total	R-Side	D-Side	Total	R-Side	D-Side	Total
Team Comm. On-Task	53.3	58.3	112	62.4	62.5	125	61.8	58.8	121
TC Non-Task-Related	24.3	22	46.3	4.88	4.38	9.26	4	3.75	7.75
TC Noncodable	8.25	5.25	13.5	5	2.38	7.38	5	3.25	8.25
Ground-Air Comm.	84	0	84	96.3	0	96.3	98.5	0	98.5
GA Noncodable	0.25	0	0.25	0.5	0	0.5	0	0	0
Ground-Line Comm.	0	28	28	0	40.1	40.1	0	43.5	43.5
GL Noncodable	0	1.25	1.25	0	0.38	0.38	0	1	1
Total	170	115	285	169	110	279	169	110	280

	Novice/Novice New			Novice/Novice 2nd New		
Team Comm. On-Task	63.9	65.8	130	68.6	73.7	142
TC Non-Task-Related	2.39	2.01	4.4	1.5	1.25	2.75
TC Noncodable	4.01	2.88	6.89	7.31	2.56	9.87
Ground-Air Comm.	74.3	0	74.3	78	0	78
GA Noncodable	0.25	0	0.25	0	0	0
Ground-Line Comm.	0	37.6	37.6	0	44	44
GL Noncodable	0	0.06	0.06	0	0	0
Total	145	108	254	155	122	277

Two-way ANOVA's were conducted on the two measures of ground-air and ground-line communication. The 8 by 2 factorial design included team type and workload. The analysis of the combined ground-air speech turns showed significant main effects for both team type ($F = 5.24$, $df = 7, 56$, $p < .05$) and workload ($F = 20.75$, $df = 1, 56$, $p < .05$). The main effect for workload established that radar controllers made significantly more ground-air speech turns when working the heavy workload problems. This finding confirms that the heavy workload problems did require the R-side controller to communicate more with pilots as compared with the moderate workload problems. The analysis of team types showed that the novice teams used significantly fewer ground-air speech turns than did the expert/intermediate new (EIN) and intermediate/intermediate new (IIN) teams. There were no significant differences for the ground-air noncodable category, indicating that the team types did not differ in their total numbers of noncodable ground-air communications.

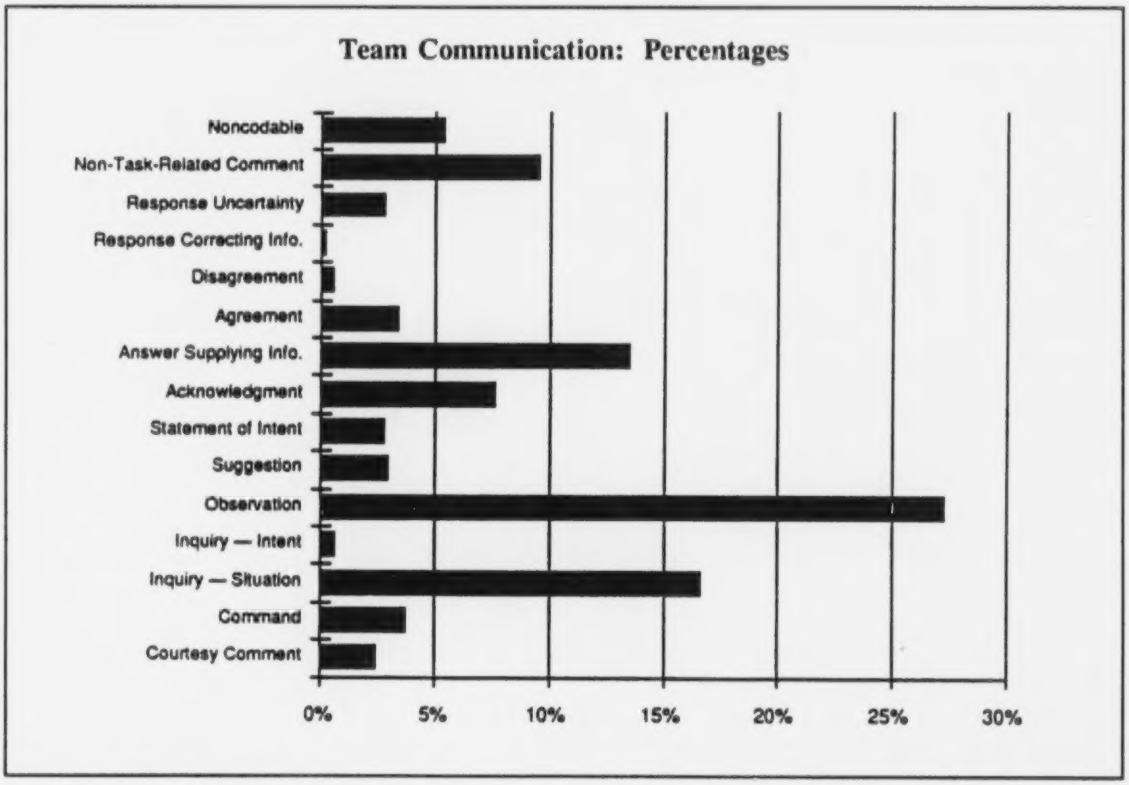
OVERALL COMMUNICATION ANALYSIS (Continued)

The results of the ground-line ANOVA's showed no significant differences for the combined ground-line speech turns. There was a significant effect of team type for the noncodable category. In general, the expert/expert new (EEN) and intermediate/intermediate new (IIN) teams had more noncodable turns than the other team types.

TEAM COMMUNICATION

The results of the team communication analyses are based on a total of 10,617 speech turns gathered from the 72 simulator sessions. The total time for these sessions was 36 hours, so there were approximately 295 team communication turns for every hour of simulator session time. As shown in Figure 3.1, "observation" is the single largest category of speech, accounting for 27.29 percent of all team speech turns. The next largest category is "inquiry—situational," accounting for 16.7 percent of team communication turns. The third largest category is "answer supplying information" which accounts for 13.54 percent of the turns. These three categories combine to make up more than half of the speech turns used by the controllers in these simulations.

Figure 3.1. Percentages of Team Communication Categories for All 72 Sessions



TEAM COMMUNICATION (Continued)

At the other end of the spectrum, the following categories each made up less than 1 percent of the total team communication: "inquiry—intent," "disagreement," and "response correcting information." The combined communication categories that make up nonroutine communication (i.e., "disagreement," "response correcting information," and "response uncertainty") accounted for less than 5 percent of all team communication.

Three-way ANOVA's were conducted for each team communication category. The three factors were team type (eight team types), controller side (R-side and D-side), and workload (moderate and heavy). The most consistent finding across the 15 ANOVA's was the significant main effect of controller side for 10 of the 15 communication categories. Figure 3.2 represents these differences between R-side and D-side team communications.

The R-side controller uses significantly more of the following speech categories as compared to the D-side:

Courtesy Comment
Inquiry—Situational
Statement of Intent
Acknowledgment
Response Uncertainty
Noncodable

The D-side controller uses significantly more of the following speech categories as compared to the R-side:

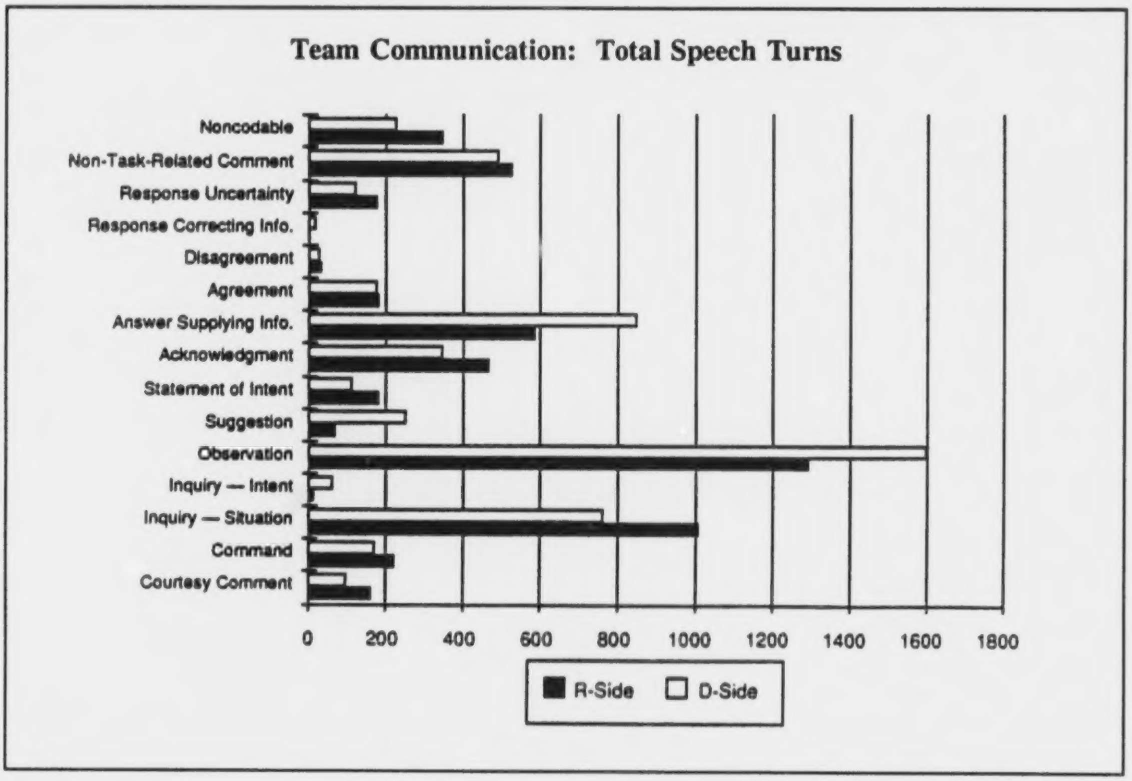
Inquiry—Intent
Observation
Suggestion
Answer Supplying Information

There were no significant main effects for workload, indicating that an increase from moderate to heavy workload did not change the overall frequencies of team communication speech categories. Based on the results of the general analysis reported in the previous section, it is evident that workload did have an overall effect on ground-air communication frequencies, but there was no similar effect on team communication.

Five of the communication categories had significant main effects for team type: "command," "suggestion," "statement of intent," "disagreement," and "non-task-related comment." For these five categories, there were significant differences among some of the eight team types ($p < .05$).

TEAM COMMUNICATION (Continued)

Figure 3.2. R-Side and D-Side Use of All Team Communication Categories



For the "command" category, a subsequent Duncan New Multiple Range test for multiple comparisons applied to the means associated with team type revealed significant differences in numbers of commands among the following team types (at the p < .05 level):

Expert/expert, new teams (Mean = 1.25)	vs.	Intermediate/intermediate, established teams (Mean = 3.6) Novice/novice, second new teams (Mean = 3.719) Novice/novice, new teams (Mean = 4.175)
Expert/intermediate, new teams (Mean = 1.344)	vs.	Intermediate/intermediate, established teams (Mean = 3.6) Novice/novice, second new teams (Mean = 3.719) Novice/novice, new teams (Mean = 4.175)
Expert/expert, established teams (Mean = 1.781)	vs.	Novice/novice, new teams (Mean = 4.175)
Expert/intermediate, established teams (Mean = 1.891)	vs.	Novice/novice, new teams (Mean = 4.175)

TEAM COMMUNICATION (Continued)

The expert/expert teams and expert/intermediate teams used significantly fewer commands than the novice/novice 2nd new teams as part of their team communication. In addition, the new expert/expert and expert/intermediate teams used significantly fewer commands than did the novice/novice teams and the intermediate/intermediate established teams. In general, the more experienced teams used fewer commands as a way of interacting with the other team members.

For the "suggestion" category, a Duncan New Multiple Range test for multiple comparisons showed that the novice/novice 2nd team type (Mean = 4.22) used significantly more suggestions than any other team type except the novice/novice new teams and the intermediate/intermediate established teams.

For the "statement of intent" category, a Duncan New Multiple Range test showed that the intermediate/intermediate established teams (Mean = 2.94) used significantly more statements of intent than either of the expert/expert team types. Furthermore, there was a significant main effect for side ($F = 9.82$, $df = 1, 112$, $p < .05$). The R-side controllers (Mean = 2.54) used significantly more statements of intent than did the D-side controllers (Mean = 1.57).

For the "disagreement" category, a Duncan New Multiple Range test showed that the novice/novice 2nd new teams had significantly more disagreements than did either of the expert/intermediate team types.

For the "non-task-related comment" category, a Duncan New Multiple Range test showed that both of the expert/expert team types made significantly more non-task-related comments compared with all the other team types. In addition, the novice/novice 2nd new teams made significantly fewer non-task-related comments than the expert/intermediate and intermediate/intermediate established team types.

Team Communication and Performance

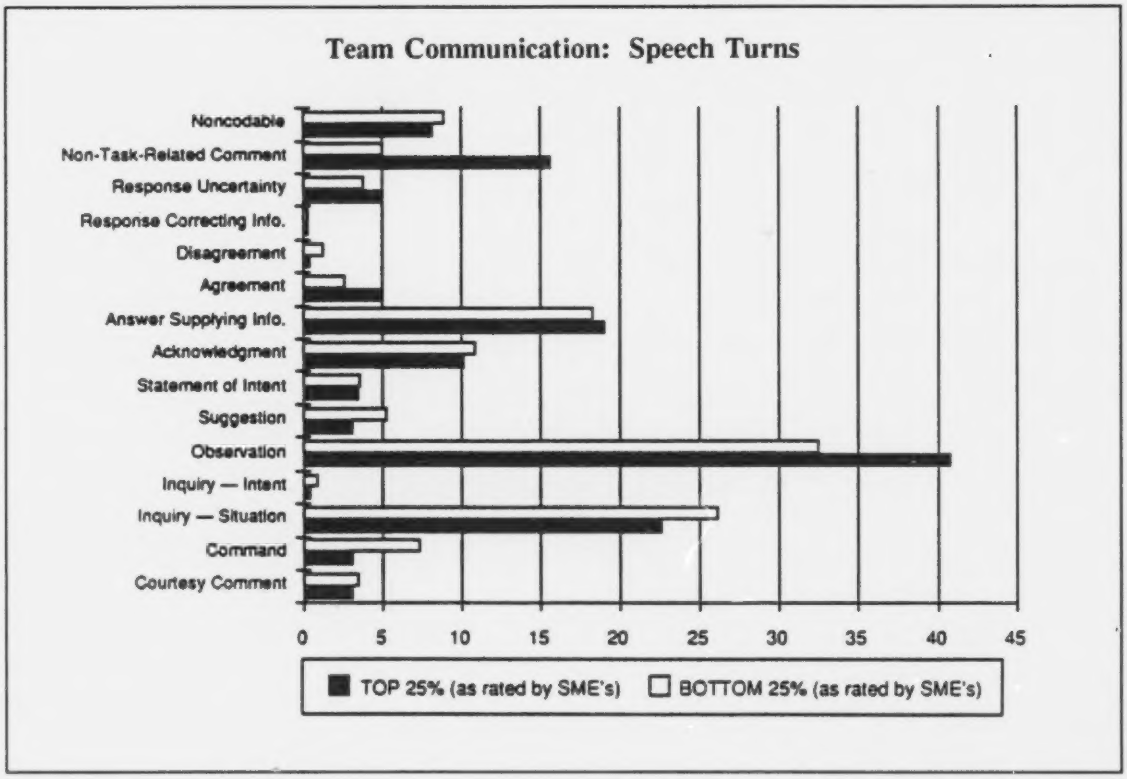
Team communication frequencies were compared for the top 25 percent and bottom 25 percent of all sessions based on three performance measures:

Overall Team Operation Ratings By Subject-Matter Experts (SME's)
Total Number of Nonroutine Communications (from the coded transcripts)
Total Number of Communication Inaccuracies (as tallied by SME's)

Team Communication and Performance (Continued)

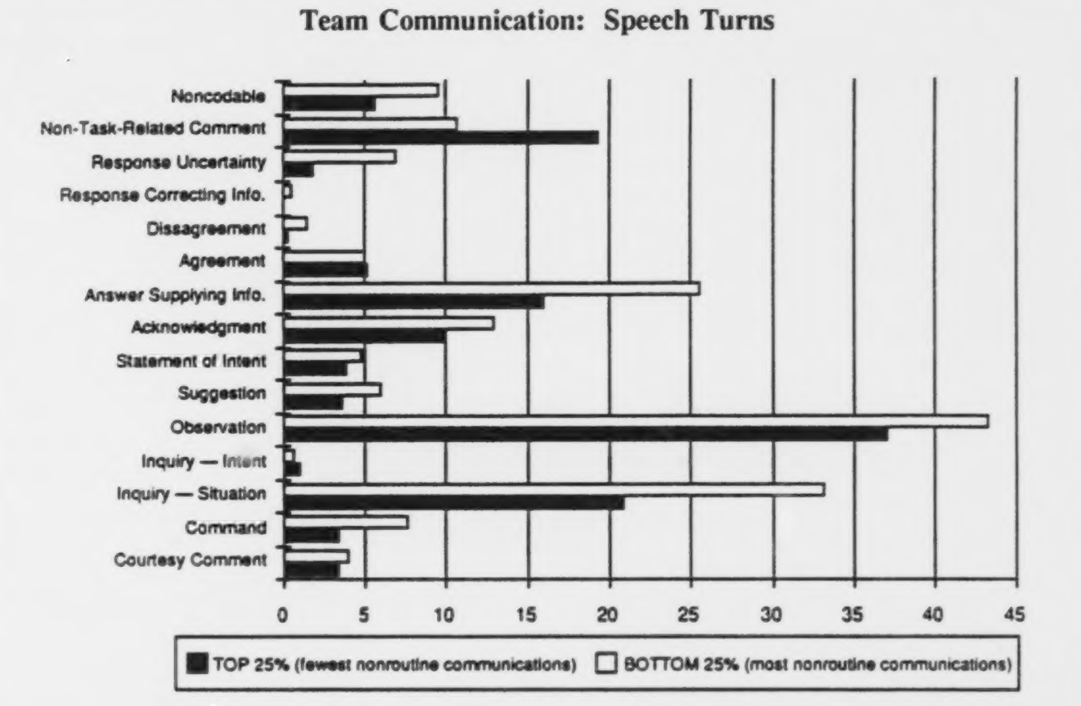
Two-way ANOVA's were performed on the 15 speech turn categories for all three performance measures to determine the significant differences between the top 25 percent of the sessions and the bottom 25 percent. The factors for these ANOVA's were level of performance (top 25 percent and bottom 25 percent) and workload (moderate and heavy). The results from the SME Overall Team Operation and Nonroutine Communication ANOVA's (see Figures 3.3 and 3.4) combine to present a coherent picture of good team communication.

Figure 3.3. Team Communication Speech Turns for Top and Bottom 25 Percent of Sessions Based on SME Overall Team Operation Ratings



Team Communication and Performance (Continued)

Figure 3.4. Team Communication Speech Turns for Top and Bottom 25 Percent of Sessions Based on Nonroutine Communication



The SME Overall Team Operation ANOVA's produced significant main effects for the following five communication categories: "command," "observation," "agreement," "disagreement," and "non-task-related comment." These results showed that in the top-rated sessions, controllers used significantly fewer commands in their team communication (F = 12.26, df = 1, 68, $p < .05$). These controllers also expressed significantly fewer disagreements (F = 4.32, df = 1, 68, $p < .05$) as compared with the bottom-rated sessions. During these top-rated sessions, the controllers made significantly more observations (F = 4.53, df = 1, 68, $p < .05$) and showed agreement more frequently (F = 5.8, df = 1, 68, $p < .05$) as compared with controllers in the bottom-rated sessions. The controllers from top-rated sessions also made significantly more non-task-related comments (F = 12.35, df = 1, 68, $p < .05$).

Team Communication and Performance (Continued)

The Nonroutine Communication ANOVA's showed a somewhat different view of good controller team communication by emphasizing the types of speech turns that occur less frequently in the top 25 percent of sessions. The Nonroutine Communication ANOVA's produced some significant main effects that reinforced two of the SME Overall Team Operation findings. First, controllers in the top sessions (sessions with the fewest nonroutine communications) used significantly fewer commands ($F = 17.55$, $df = 1, 68$, $p < .05$) than those controllers in the bottom performing sessions. In addition, controllers from sessions with the fewest nonroutine communications used significantly fewer situational inquiries ($F = 15.52$, $df = 1, 68$, $p < .05$) as compared to controller from sessions with the most nonroutine communications. Controllers from the top sessions also used fewer answers supplying information ($F = 10.75$, $df = 1, 68$, $p < .05$) and had fewer response uncertainties ($F = 42.22$, $df = 1, 68$, $p < .05$). The results showing fewer disagreements and response uncertainties were expected because those two categories are both measures of Nonroutine Communication.

Two significant interactions between performance level and workload further illustrate how the controllers with fewest nonroutine communications differ from those with the most. First was a significant interaction between performance level and workload for "agreement" ($F = 6.2$, $df = 1, 68$, $p < .05$). A further analysis of that interaction shows the relationship illustrated in Figure 3.5 where top performers make relatively fewer statements of agreement under moderate workload as compared to heavy workload. On the other hand, those with the most nonroutine communications make more statements of agreement when experiencing moderate workload as compared to heavy workload.

Team Communication and Performance (Continued)

Figure 3.5. Interaction Plot of Performance by Workload for Agreement

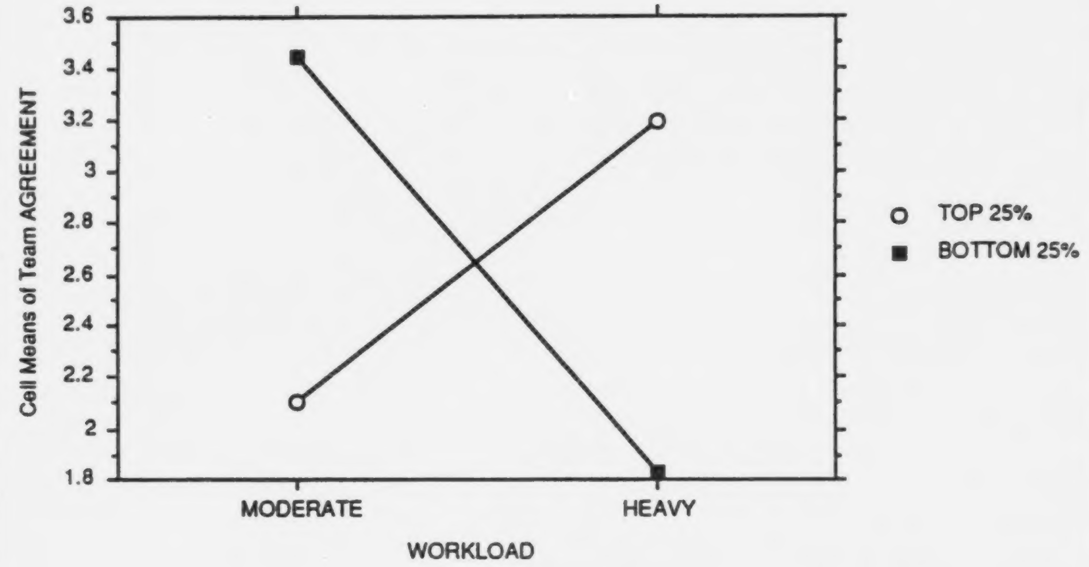
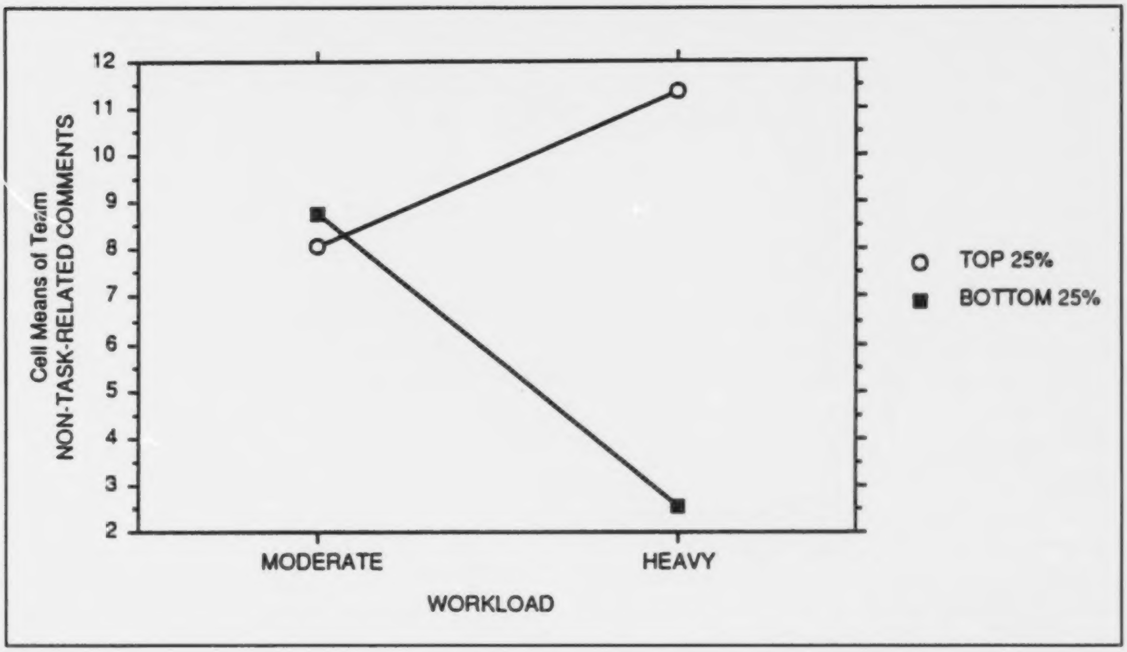


Figure 3.6 shows the interaction for the "non-task-related comment" category. There was a significant interaction between performance level and workload for non-task-related comments (F = 5.17, df = 1, 68, p < .05). Controllers in the top 25 percent of these sessions made more non-task-related comments while experiencing heavy workload as compared to moderate workload, and those in the bottom 25 percent made fewer non-task-related comments when under heavy workload.

Team Communication and Performance (Continued)

Figure 3.6. Interaction Plot of Performance by Workload for Non-Task-Related Comments



The final set of ANOVA's on Communication Inaccuracies confirmed that in the top sessions (i.e., those with the fewest communication inaccuracies), controllers expressed fewer disagreements.

By combining the results from these analyses of top-performance versus bottom-performance sessions, one can describe the team speech turn characteristics of the top sessions. The sessions rated as having overall better operation with fewer nonroutine communications had significantly fewer of the following types of speech turns:

Command
Inquiry—Situation
Answer Supplying Information
Disagreement
Response Uncertainty

Team Communication and Performance (Continued)

At the same time, the controllers in the top performance sessions were likely to use more of the following:

Observation
Agreement

Correlations were calculated between the three performance measures (i.e., SME overall team operation ratings, nonroutine communications, and communication inaccuracies) and the objective and subjective measures as well as demographic data. The correlations between the performance measures and the objective measures (see Appendix A) support the findings of the ANOVA's for "command," "inquiry—situational," "answer supplying information," "disagreement," and "response uncertainty." That is, the better the performance, the lower the frequencies of team commands, situational inquiries, answers supplying information, disagreements, and response uncertainties.

The correlations with demographic data added to the understanding of what constitutes a top performing team. First, the correlation between SME overall team operation ratings and D-side controller experience ($r = .27$, $n = 72$) was significant at the .05 level as was the correlation between SME overall team operation ratings and D-side FPL experience ($r = .25$, $n = 72$). These two correlations indicate that those teams with more D-side experience were more highly rated in terms of performance. It is interesting to note that R-side controller experience did not have a significant correlation with any of the three performance measures.

The correlation data showed several relationships between the subjective ratings of the teams and the measures of performance. The correlations between SME overall team operation ratings and situational awareness ($r = .37$, $n = 72$), adaptability/flexibility ($r = .27$, $n = 72$), teamwork ($r = .32$, $n = 72$), decisionmaking ($r = .38$, $n = 72$), and overall teamwork ($r = .36$, $n = 72$) were all significant at the $p < .05$ level. These results indicate that the teams that rated themselves higher on the following categories also received higher SME overall team operation ratings:

Situational Awareness
Adaptability and Flexibility
Teamwork
Decisionmaking
Overall Teamwork

In addition, the significant negative correlation between SME overall team operation ratings and the subjective ratings of sector busyness indicates that the controllers who thought the sector was less busy received higher SME overall ratings.

Team Communication and Performance (Continued)

In general, top-performing controller teams exchange fewer commands, situational inquiries, suggestions, and answers supplying information. These top teams also have fewer nonroutine communications (i.e., disagreement and response uncertainty). On the other hand, the top teams rely on more observations and agreements. In addition, the D-side controller is likely to have more experience, and the top performing team members will rate themselves higher on situational awareness, adaptability/flexibility, decisionmaking, and teamwork. Finally, these top performers are likely to rate the sector as less busy compared to the bottom performers.

GROUND-AIR COMMUNICATION

The results of the ground-air communication analyses are based on a total of 6,161 speech turns gathered from the 72 simulator sessions. All these ground-air communication turns were made by the R-side controllers. As shown in Figure 3.7, over 65 percent of these turns were "commands" issued to pilots. The next most frequent ground-air category was "acknowledgments" at 14.53 percent, followed by "reports" at 9.39 percent. Finally, R-side controller "inquiries" accounted for 7 percent of the ground-air communication, with the remaining categories making up less than 5 percent of this form of communication. This last group includes "response correcting presented information" and "response uncertainty," the two categories that make up nonroutine ground-air communication.

GROUND-AIR COMMUNICATION (Continued)

There was a significant main effect of team type (F = 4.93, df = 7, 56, $p < .05$) for "command." A Duncan New Multiple Range test showed that the expert/intermediate and the intermediate/intermediate new teams used significantly more commands ($p < .05$) than did either of the expert/expert or the novice/novice teams. There was also a significant main effect of team type (F = 3.89, df = 7, 56, $p < .05$) for "report." A Duncan New Multiple Range test showed that the novice/novice new teams made significantly fewer reports ($p < .05$) than the expert/expert, intermediate/intermediate, and expert/intermediate established teams. The novice/novice new teams also made significantly fewer reports than the expert/intermediate and intermediate/intermediate new team types. The final significant main effect of team type (F = 2.6, df = 7, 56, $p < .05$) was for "non-task-related comment." A Duncan New Multiple Range test showed that expert/expert new teams made significantly more non-task-related comments ($p < .05$) than the seven other team types.

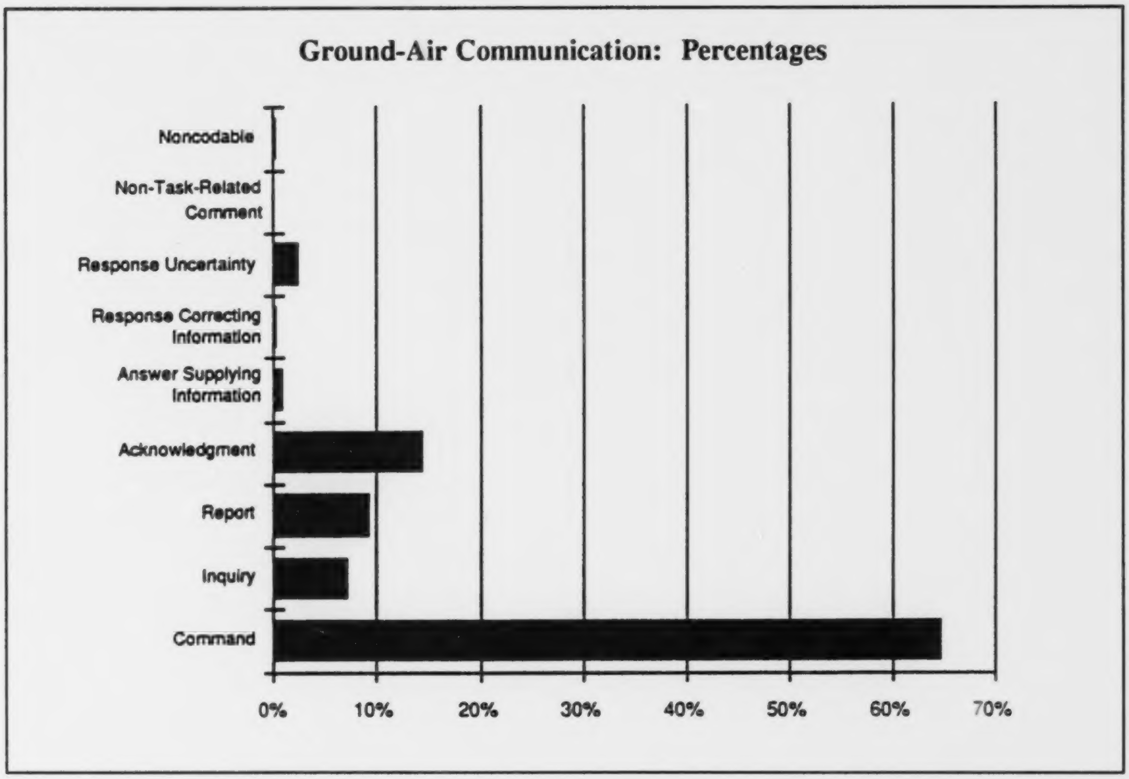
A comparison of ground-air speech turns was made between the top 25 percent and the bottom 25 percent of sessions based on the following three performance measures:

Overall Team Operation Ratings By SME's
Total Number of Nonroutine Communications (from the coded transcripts)
Total Number of Communication Inaccuracies (as tallied by SME's)

Figure 3.8 shows the results for the SME Overall Team Operation Ratings comparison of the top 25 percent and bottom 25 percent of all sessions. Two-way ANOVA's were conducted for each ground-air communication category. The two factors were performance level and workload. Workload was a significant main effect for the two most frequent ground-air categories, "command" (F = 4.2, df = 1, 32, $p < .05$) and "acknowledgment" (F = 15.15, df = 1, 32, $p < .05$). In both cases, there was more frequent use of those speech turn categories under the condition of heavier workload. In addition, there was a significant main effect of workload (F = 4.77, df = 1, 32, $p < .05$) for "noncodable" speech turns. There were significantly more noncodable turns for the heavy workload problems as compared to the moderate workload problems.

GROUND-AIR COMMUNICATION (Continued)

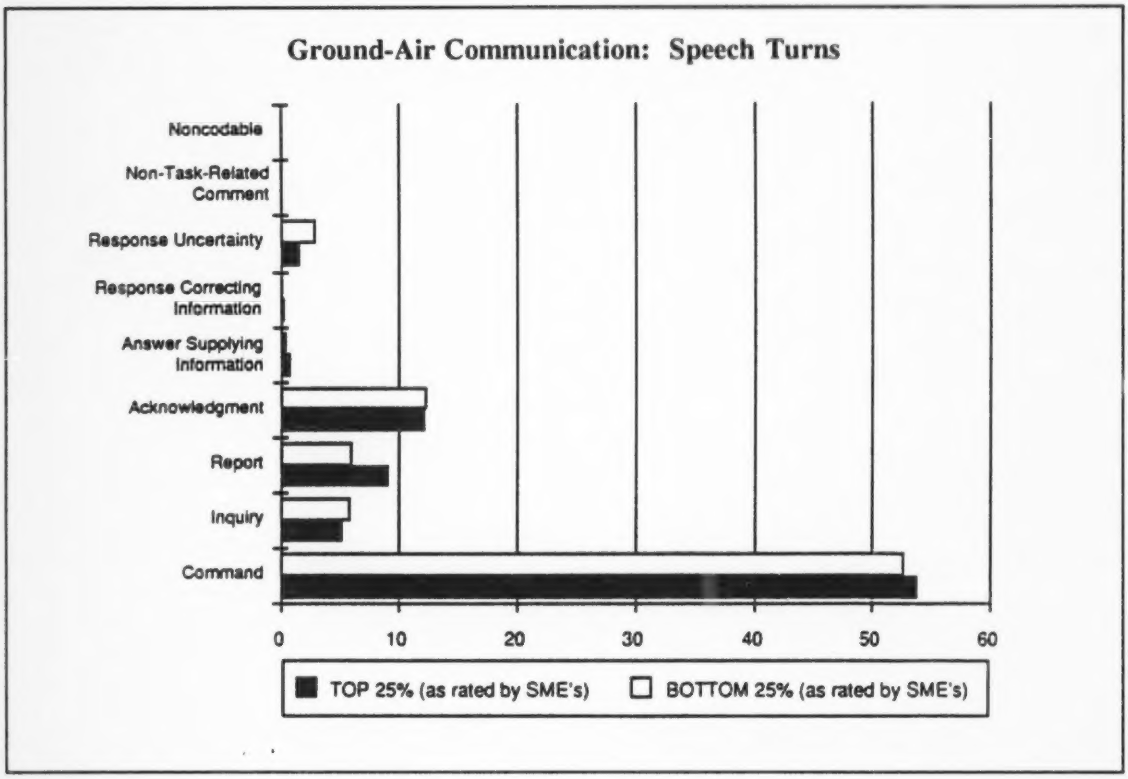
Figure 3.7. Percentages of Ground-Air Communication Categories for All 72 Sessions



Two-way ANOVA's were conducted for each ground-air communication category. The two factors were team type (eight team types) and workload (moderate and heavy). Workload was a significant main effect for the two most frequent communication categories, "command" (F = 20.90, df = 1, 56, p < .05) and "acknowledgment" (F = 19.3, df = 1, 56, p < .05). In both cases, more frequent use of those speech turn types occurred under the condition of heavier workload. This finding adds detail to the finding reported earlier in the general analysis section that the R-side controller used more speech turns when working the heavy workload problems. The radar controllers do issue more commands and acknowledgments to pilots when experiencing a heavy workload.

GROUND-AIR COMMUNICATION (Continued)

Figure 3.8. Ground-Air Speech Turns for Top and Bottom 25 Percent of Sessions Based on SME Overall Team Operation Ratings

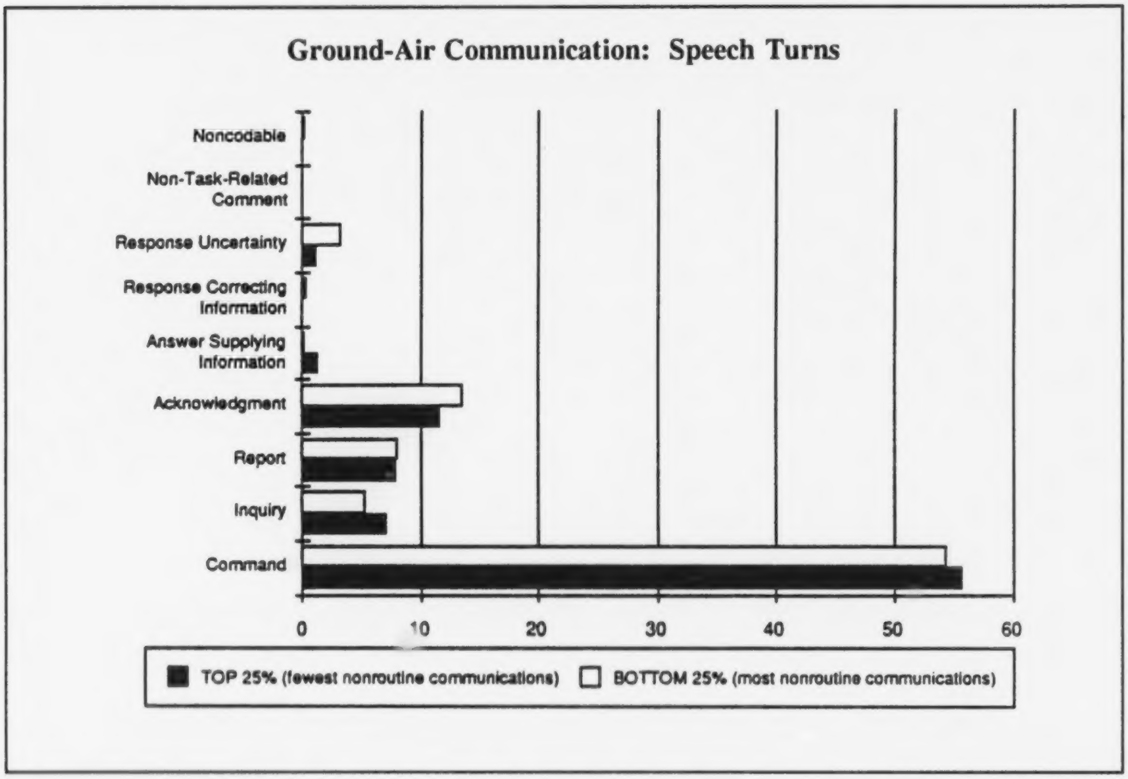


The SME Overall Team Operation Ratings showed significant main effects for two air-ground categories. There was a significant main effect of performance level (F = 5.42, df = 1, 32, $p < .05$) for "report." Controllers in the top-rated sessions used significantly more reports than did those in the bottom-rated sessions. There was also a significant main effect of performance level (F = 4.35, df = 1, 32, $p < .05$) for "response uncertainty." Controllers in the top-rated sessions had significantly fewer responses expressing uncertainty than did those in the bottom-rated sessions.

Figure 3.9 shows the results for the Nonroutine Communications comparison of the top 25 percent and bottom 25 percent of all sessions. Two-way ANOVA's were conducted for each ground-air communication category. The two factors were performance level and workload. This analysis also showed significant main effects of workload for "command" (F = 14.56, df = 1, 32, $p < .05$) and "acknowledgment" (F = 12.76, df = 1, 32, $p < .05$). As with the SME overall operation ratings, there was more frequent use of commands and acknowledgments under the condition of heavier workload.

GROUND-AIR COMMUNICATION (Continued)

Figure 3.9. Ground-Air Speech Turns for Top and Bottom 25 Percent of Sessions Based on Nonroutine Communication

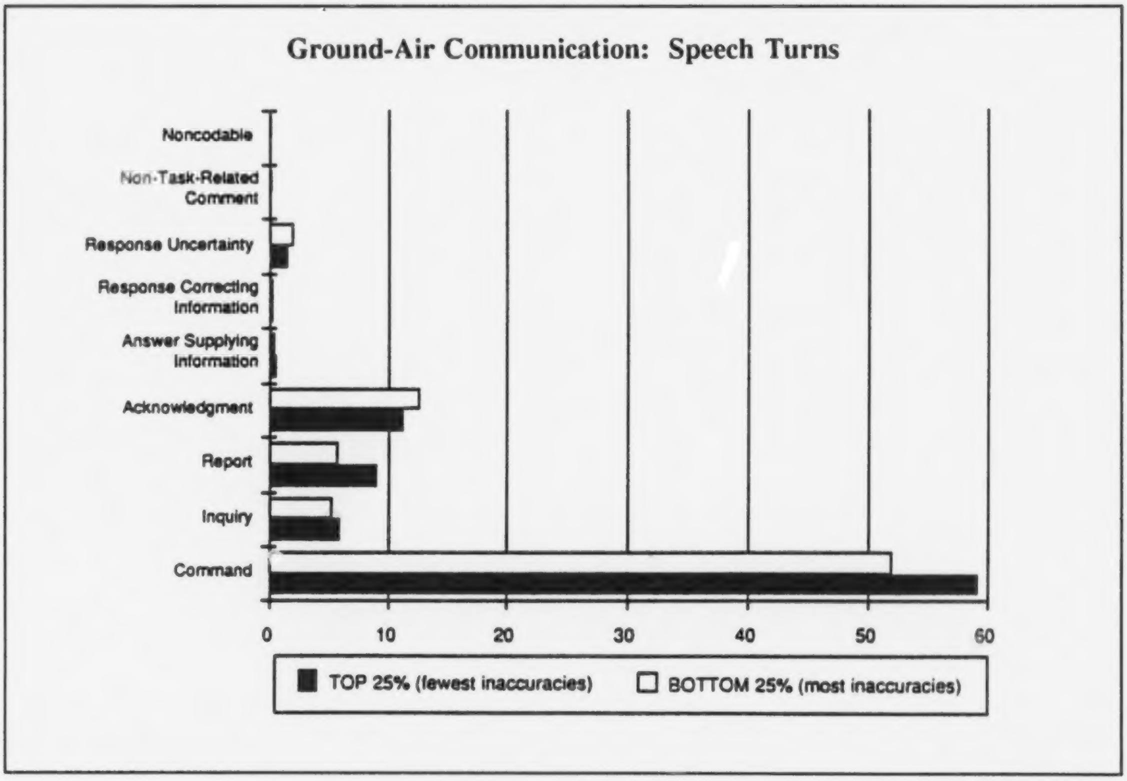


The Nonroutine Communication ANOVA's also showed significant main effects of performance level on two communication categories. There was a significant main effect of performance level (F = 9.47, df = 1, 32, p < .05) for "answer supplying information." Controllers in the top-rated sessions used significantly more answers supplying information than did those in the bottom-rated sessions. There was also a significant main effect of performance level (F = 13.78, df = 1, 32, p < .05) for "response uncertainty." As with the SME ratings, controllers in the top-rated sessions used significantly fewer responses expressing uncertainty than did those in the bottom-rated sessions.

GROUND-AIR COMMUNICATION (Continued)

Figure 3.10 shows the results for the top and bottom 25 percent of sessions based on Communication Inaccuracies. Two-way ANOVA's were conducted for each ground-air communication category. The two factors were performance level and workload. This analysis supported the previous two analyses by showing significant main effects of workload for "command" ($F = 15.22$, $df = 1, 32$, $p < .05$) and "acknowledgment" ($F = 6.02$, $df = 1, 32$, $p < .05$). In addition, there was a significant main effect of workload for "response correcting presented information" ($F = 4.27$, $df = 1, 32$, $p < .05$). As with the other analyses, there was more frequent use of these speech turns under the condition of heavier workload.

Figure 3.10. Ground-Air Speech Turns for Top and Bottom 25 Percent of Sessions Based on Number of Communication Inaccuracies

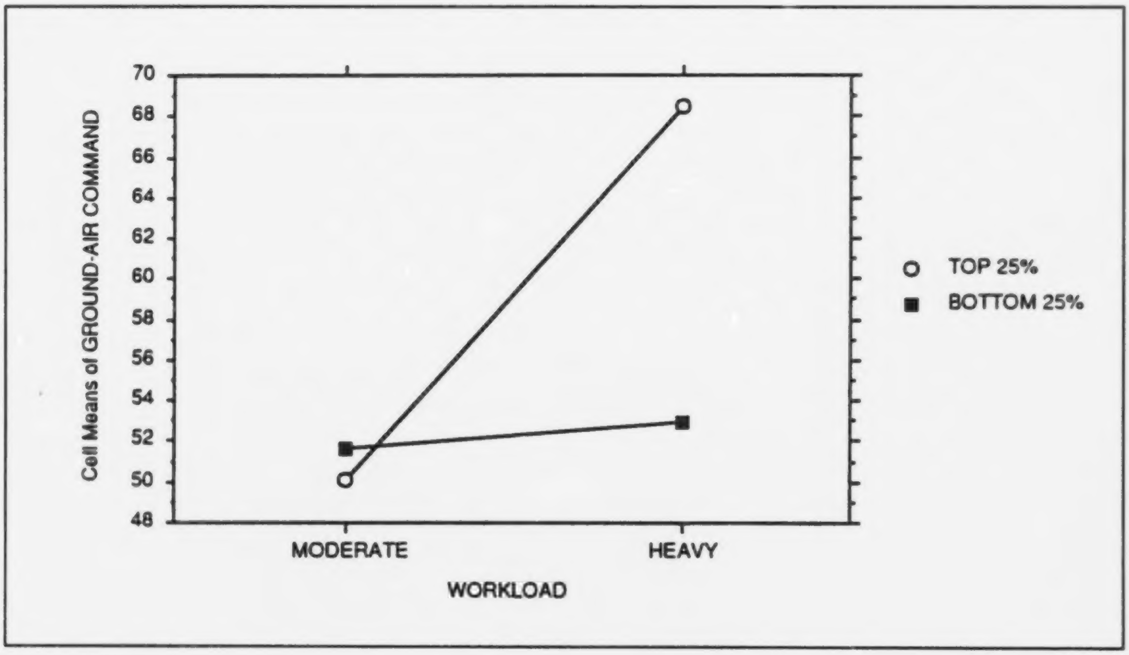


GROUND-AIR COMMUNICATION (Continued)

The Communication Inaccuracy ANOVA's also showed significant main effects of performance level on two communication categories. There was a significant main effect of performance level ($F = 7.75$, $df = 1, 32$, $p < .05$) for "command." Controllers in the top sessions used significantly more commands than did those in the bottom-rated sessions. There was also a significant main effect of performance level ($F = 11.50$, $df = 1, 32$, $p < .05$) for "report." Controllers in the top-rated sessions used significantly more reports than did those in the bottom-rated sessions.

One significant interaction between performance level and workload illustrates how controllers in the top-rated sessions differed from those in the bottom sessions. This interaction was for ground-air commands to pilots ($F = 11.36$, $df = 1, 32$, $p < .05$). An analysis of that interaction (see Figure 3.11) shows that top performers made relatively fewer commands under moderate workload as compared to heavy workload. The controllers from the sessions with the fewest communication inaccuracies account for the greater number of commands in the presence of heavy workload, while the controllers in the sessions with the most inaccuracies show little difference in commands between the two workload conditions.

Figure 3.11. Interaction Plot of Performance by Workload for Command



GROUND-AIR COMMUNICATION (Continued)

Correlations were calculated between the three performance measures (i.e., SME overall team operation ratings, nonroutine communications, and communication inaccuracies) and the objective measures of ground-air communication. The correlation between SME overall team operation and "report" ($r = .39$, $n = 72$) was significant at the $p < .05$ level, indicating that controllers in the higher-rated sessions issued more reports to pilots. This finding was confirmed by the significant negative correlation between communication inaccuracies and "report" ($r = -.41$, $n = 72$). In addition, there was a significant negative correlation between SME overall team operation and "response uncertainty" ($r = -.28$, $n = 72$). This finding was supported by a significant positive correlation between nonroutine communication and "response uncertainty" ($r = .49$, $n = 72$). These correlations support the ANOVA results indicating that top-performing teams made more reports and had fewer response uncertainties as compared to the controllers from the bottom teams.

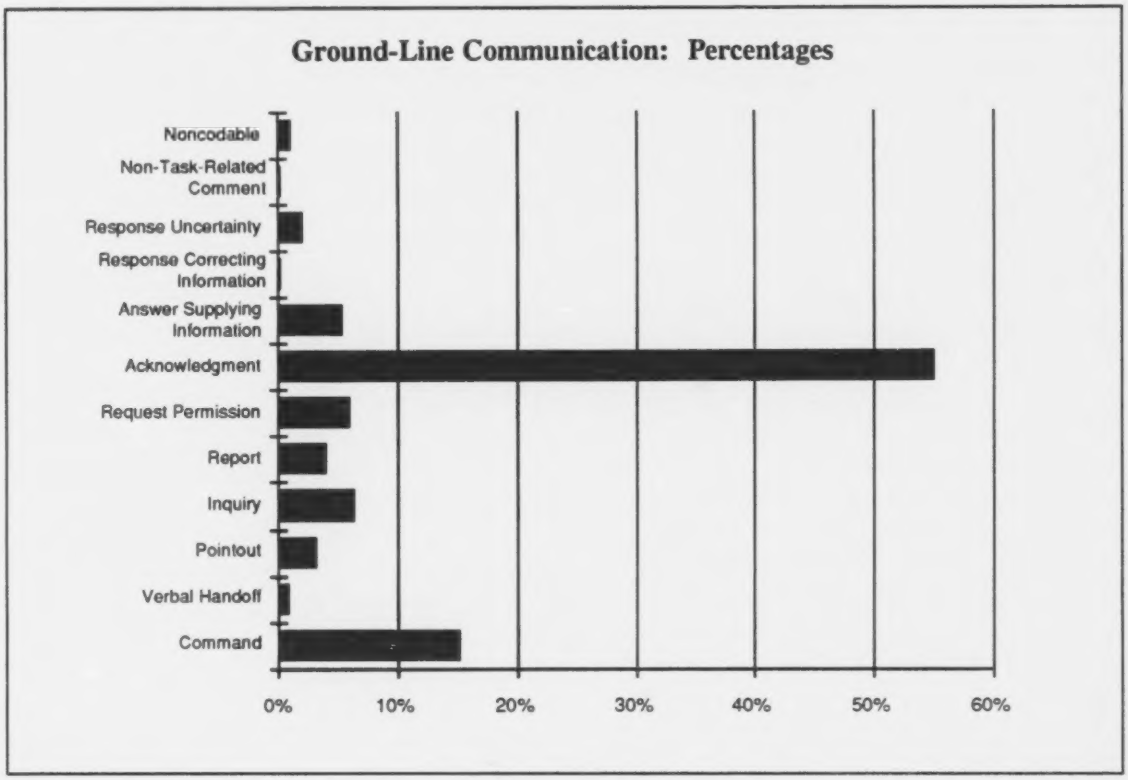
GROUND-LINE COMMUNICATION

The results of the ground-line communication analyses are based on a total of 2,745 speech turns gathered over the 72 simulator sessions. The D-side controllers made all but three of these speech turns. The D-side communication with other sectors is made up primarily of "acknowledgments," which account for 55.02 percent of all ground-line speech turns. As shown in Figure 3.12, the next most frequently used category is the "command."

Two-way ANOVA's were conducted for each ground-line communication category. The two factors were team type (eight team types) and workload (moderate and heavy). There was a significant main effect of workload ($F = 8.93$, $df = 1, 56$, $p < .05$) for "command" and ($F = 17.11$, $df = 1, 56$, $p < .05$) for "answer supplying information." In both cases, there was a greater frequency of these speech categories when experiencing heavy workload. This finding, added to those from the ground-air analyses, establishes that the heavy workload problems resulted in an increase of several key communication categories for both ground-line and ground-air communications.

GROUND-LINE COMMUNICATION (Continued)

Figure 3.12. Percentages of Ground-Line Communication Categories for All 72 Sessions



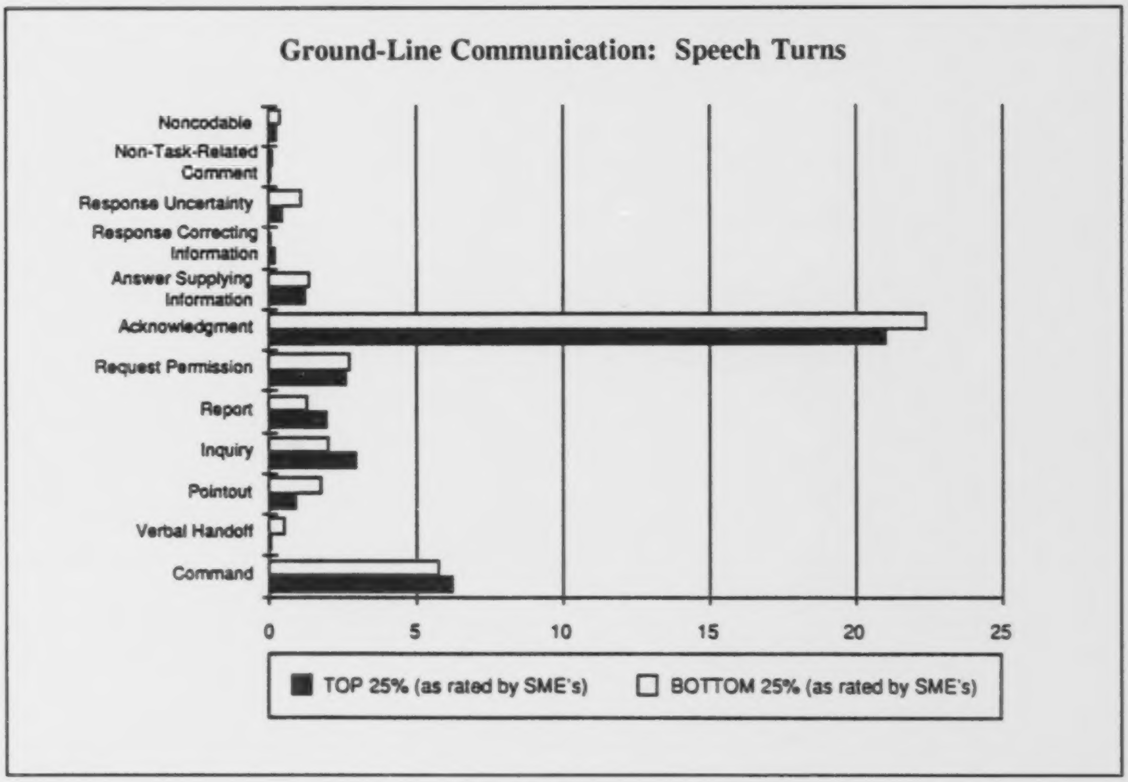
There was also a significant main effect of workload (F = 7.82, df = 1, 56, p < .05) for "pointout." There were significantly fewer pointouts in the heavy workload sessions. Contrary to the findings for "command" and "answer supplying information," which showed a significant increase with higher workload, "pointouts" showed a significant decrease in sessions with the heavy workload problems.

There was a significant main effect of team type (F = 3.21, df = 7, 56, p < .05) for "acknowledgment." A Duncan New Multiple Range test showed that the expert/expert teams used significantly fewer "acknowledgments" (p < .05) than did the expert/intermediate, intermediate/intermediate, and the novice/novice new teams. There was also a significant main effect of team type (F = 2.38, df = 7, 56, p < .05) for "noncodable" communications. A Duncan New Multiple Range test showed that expert/expert and intermediate/intermediate new teams had significantly more noncodable turns (p < .05) than the novice/novice team types. Also, the expert/expert new teams had significantly more noncodable turns (p < .05) than the expert/intermediate teams.

GROUND-LINE COMMUNICATION (Continued)

Two-way ANOVA's were performed on the 12 ground-line speech turn categories to determine the differences between the top 25 percent of the sessions and the bottom 25 percent (see Figure 3.13). The factors for these ANOVA's were SME-rated level of performance (top 25 percent and bottom 25 percent) and workload (moderate and heavy).

Figure 3.13. Ground-Line Speech Turns for Top and Bottom 25 Percent of Sessions Based on SME Overall Team Operation Ratings



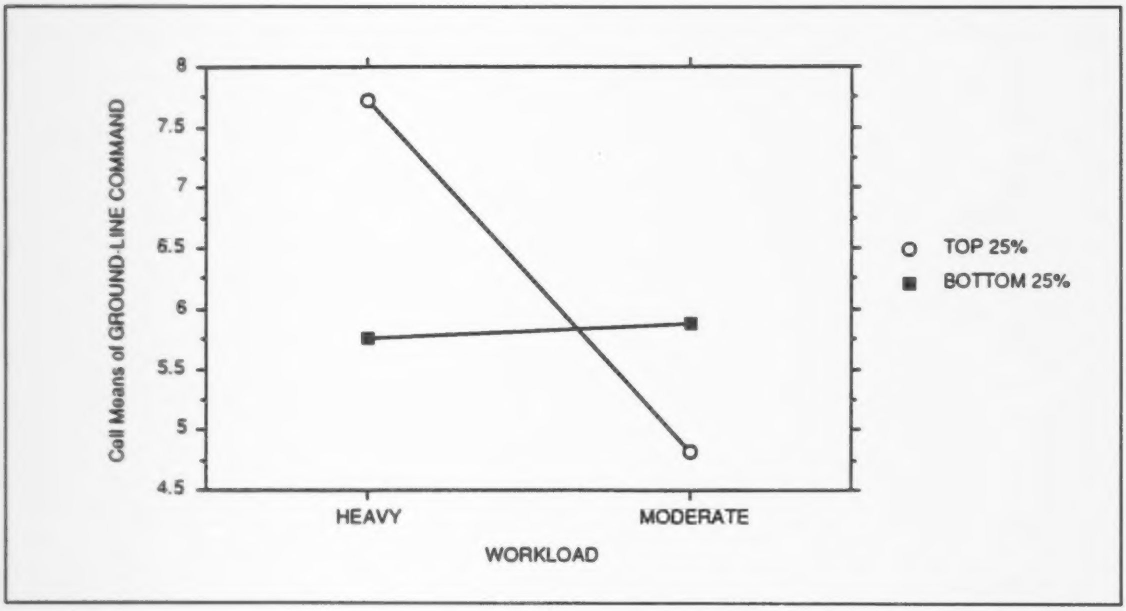
Workload was a significant main effect for three of the categories: "verbal handoff" (F = 7.34, df = 1, 32, p < .05), "pointout" (F = 6.59, df = 1, 32, p < .05) and "answer supplying information" (F = 4.35, df = 1, 32, p < .05). In the case of verbal handoffs and answers supplying information, there was more frequent use when controllers were experiencing heavy workload. Pointouts showed the opposite effect with greater use of that form of communication when working the moderate workload problems.

GROUND-LINE COMMUNICATION (Continued)

The SME Overall Operation Ratings showed significant main effects for two ground-line categories. There was a significant main effect of performance level (F = 4.46, df = 1, 32, p < .05) for "verbal handoffs." Controllers in the top-rated sessions used significantly fewer verbal handoffs than did those in the bottom-rated sessions. There was also a significant main effect of performance level (F = 4.84, df = 1, 32, p < .05) for "pointouts." Again, controllers in the top-rated sessions used significantly fewer pointouts than did those in the bottom-rated sessions.

Two significant interactions between performance level and workload for the categories "command" and "verbal handoff" illustrate how controllers in the top-rated sessions cope with a heavy workload. The first interaction was for ground-line commands to other sectors (F = 4.48, df = 1, 32, p < .05). An analysis of that interaction shows the relationship illustrated in Figure 3.14. Controllers from the top-rated sessions made relatively fewer commands under moderate workload as compared to heavy workload. The top controllers account for the greater number of commands in the presence of heavy workload while the controllers in the bottom-rated sessions show little difference in their use of commands between the two workload conditions.

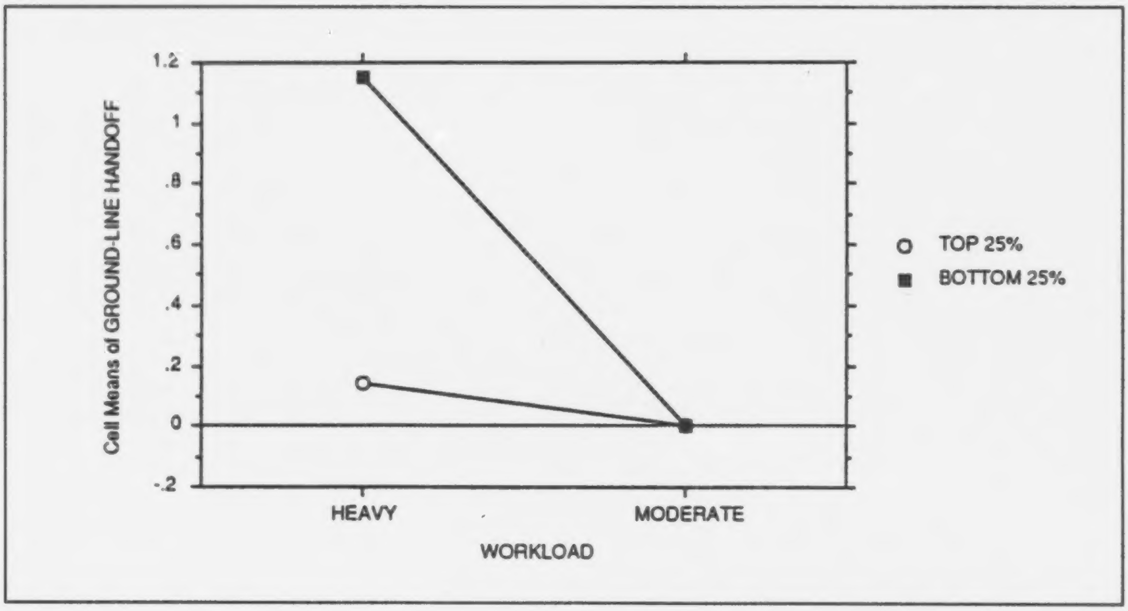
Figure 3.14. Interaction Plot of Performance by Workload for Command



GROUND-LINE COMMUNICATION (Continued)

The second interaction between performance level and workload was for verbal handoffs to other sectors ($F = 4.46$, $df = 1, 32$, $p < .05$). The interaction is shown in Figure 3.15. This particular interaction differs from the others in that controllers from the top-rated sessions made no verbal handoffs in moderate workload, and very few in heavy workload. On the other hand, the controllers from the bottom-rated sessions showed a significant increase in verbal handoffs when working the heavy workload problems. This may be a key finding indicating that the top-rated D-side controllers better manage their time when working the heavier workloads. As seen in the previous interaction, they issue more commands to other sectors, but they also keep the number of verbal handoffs to a minimum.

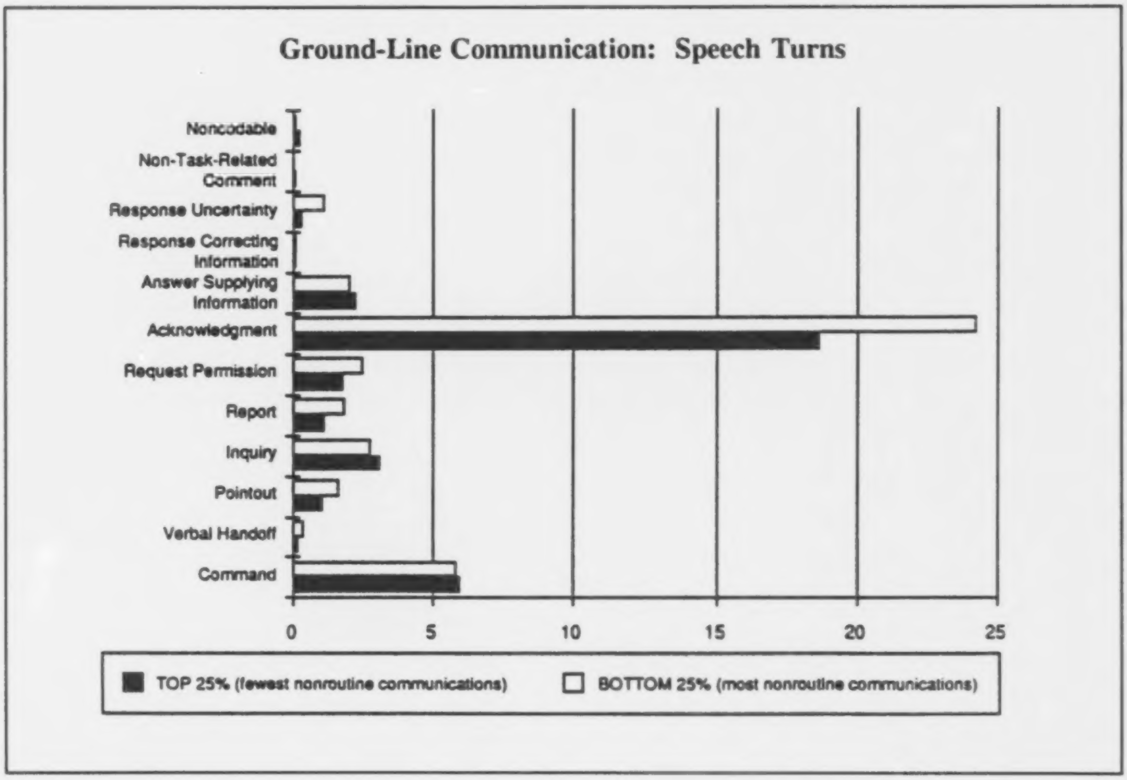
Figure 3.15. Interaction Plot of Performance by Workload for Verbal Handoff



GROUND-LINE COMMUNICATION (Continued)

Two-way ANOVA's were also performed on the 12 speech turn categories to determine the significant differences between the top 25 percent and the bottom 25 percent based on number of nonroutine communications (see Figure 3.16). The factors for these ANOVA's were level of performance (top 25 percent and bottom 25 percent) and workload (moderate and heavy).

Figure 3.16. Ground-Line Speech Turns for Top and Bottom 25 Percent of Sessions Based on Nonroutine Communication



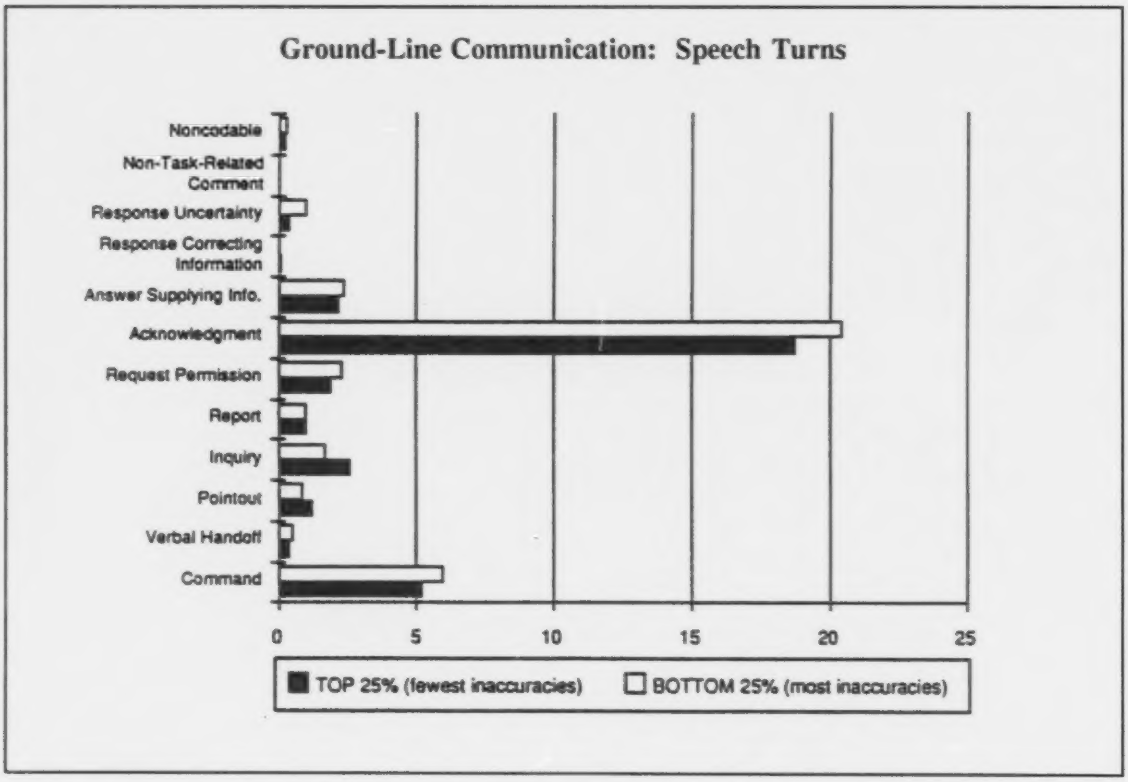
Workload was a significant main effect for the following two communication categories: "verbal handoff" ($F = 6.43$, $df = 1, 32$, $p < .05$) and "answer supplying information" ($F = 9.75$, $df = 1, 32$, $p < .05$). These two results lend support to the SME Overall Team Operation findings. In both cases, there was more frequent use of these categories when experiencing heavy workload. There was an additional significant main effect of workload ($F = 5.67$, $df = 1, 32$, $p < .05$) for "acknowledgment." The heavy workload problems produced significantly more acknowledgments.

GROUND-LINE COMMUNICATION (Continued)

The nonroutine communication ANOVA's also showed significant main effects of performance level for two communication categories. There was a significant main effect of performance level (F = 6.04, df = 1, 32, p < .05) for "acknowledgment." Controllers in the sessions with the least number of nonroutine communications used significantly fewer acknowledgments than did those in the sessions with the most nonroutine communications. There was also a significant main effect of performance level (F = 4.66, df = 1, 32, p < .05) for "response uncertainty." Controllers in the top sessions had significantly fewer response uncertainties than did those in the bottom sessions.

Finally, two-way ANOVA's were performed on the 12 speech turn categories to determine the significant differences between the top 25 percent and the bottom 25 percent based on communication inaccuracies (see Figure 3.17). The factors for these ANOVA's were level of performance (top 25 percent and bottom 25 percent) and workload (moderate and heavy).

Figure 3.17. Ground-Line Speech Turns for Top and Bottom 25 Percent of Sessions Based on Number of Communication Inaccuracies



GROUND-LINE COMMUNICATION (Continued)

The only significant main effect was workload for the following three ground-line communication categories: "command" ($F = 5.24$, $df = 1, 32$, $p < .05$), "pointout" ($F = 6.33$, $df = 1, 32$, $p < .05$), and "answer supplying information" ($F = 5.08$, $df = 1, 32$, $p < .05$). Two of the results, "pointout" and "answer supplying information" lend support to the previous findings. In the case of "pointout," there was less frequent use of this category when experiencing heavy workload. As for "answer supplying information," there was more frequent use of this category when experiencing heavy workload. In the case of "command," the heavy workload problems produced significantly more ground-line commands as compared to the moderate workload problems.

Correlations were calculated between the three performance measures (i.e., SME overall team operations ratings, nonroutine communications, and communication inaccuracies) and the objective measures of ground-line communication. The negative correlation was significant between SME overall team operation and "verbal handoff" ($r = -.27$, $n = 72$). This correlation supports the finding that controllers in top-rated sessions use fewer verbal handoffs. In addition, there was a significant correlation between nonroutine communication and "response uncertainty" ($r = .24$, $n = 72$). This correlation also confirms that those sessions with fewer nonroutine communications had fewer response uncertainties.

The results of the SME overall team operation ratings, nonroutine communications, and communication inaccuracy ANOVA's combine to describe the top-performing D-side controllers as those who used significantly fewer pointouts, verbal handoffs, acknowledgments, and response uncertainties. This group of top performers was able to direct more efficient ground-line communications by limiting their use of pointouts, verbal handoffs, and acknowledgments.

NONROUTINE COMMUNICATIONS

Nonroutine communications are made up of understanding problems and information problems across all three types of communication: team, ground-air, and ground-line. There was a total of 622 nonroutine communications accounting for 3 percent of all speech turns made during the 72 simulator sessions. Understanding problems included all turns that were coded as "response uncertainty" and accounted for 82 percent of all nonroutine communications. Information problems included all turns coded as "response correcting presented information" and the team communication "disagreement" turns.

Table 3.3 shows the distribution of nonroutine communications by team type. ANOVA's of the separate and combined nonroutine communications showed that there were no significant differences among team types.

NONROUTINE COMMUNICATIONS (Continued)

Table 3.3. Mean Nonroutine Communications per Session by Team Type

	TEAM COMM*	GROUND-AIR*	GROUND-LINE*	COMBINED*
Expert/Expert Established				
Understanding Problem	4.96	1.28	1.33	7.56
Information Problem	1.37	0.19	0.00	1.56
Total Nonroutine Communication	6.33	1.47	1.33	**9.12**
Expert/Expert New				
Understanding Problem	3.13	1.38	1.50	6.00
Information Problem	1.25	0.00	0.00	1.25
Total Nonroutine Communication	4.38	1.38	1.50	**7.25**
Expert/Intermediate Established				
Understanding Problem	4.00	1.69	0.38	6.06
Information Problem	0.81	0.38	0.16	1.34
Total Nonroutine Communication	4.81	2.06	0.53	**7.41**
Expert/Intermediate New				
Understanding Problem	3.44	2.35	0.88	6.67
Information Problem	0.88	0.13	0.25	1.25
Total Nonroutine Communication	4.31	2.48	1.13	**7.92**
Intermediate/Intermediate Established				
Understanding Problem	6.44	1.97	0.63	9.03
Information Problem	0.83	0.25	0.00	1.08
Total Nonroutine Communication	7.28	2.22	0.63	**10.12**
Intermediate/Intermediate New				
Understanding Problem	3.75	2.83	0.75	7.33
Information Problem	1.25	0.75	0.25	2.25
Total Nonroutine Communication	5.00	3.58	1.00	**9.58**
Novice/Novice New				
Understanding Problem	3.98	3.03	0.84	7.86
Information Problem	1.13	0.31	0.00	1.44
Total Nonroutine Communication	5.11	3.35	0.84	**9.30**
Novice/Novice 2nd New				
Understanding Problem	3.31	2.00	0.88	6.19
Information Problem	2.19	0.25	0.00	2.44
Total Nonroutine Communication	5.50	2.25	0.88	**8.63**

* Note: Some totals do not add up exactly due to rounding.

NONROUTINE COMMUNICATIONS (Continued)

A review of the ANOVA results for nonroutine communications comparing the top and bottom 25 percent of sessions provides a clear description of the top-performing controllers. The results based on the SME Overall Team Operation Ratings ANOVA's showed that the top-performing sessions had significantly fewer team disagreements and significantly fewer ground-air response uncertainties. Secondly, the results based on communication inaccuracy confirmed that top-performing sessions had significantly fewer team disagreements. In general, controllers from top-performing sessions had fewer disagreements and made fewer responses that indicated uncertainty about a prior speech turn.

COMMUNICATION INACCURACIES

As discussed in the Methods section, the communication inaccuracies included a checklist of nine ground-air inaccuracies and ten ground-line inaccuracies. There was a total of 592 communication inaccuracies from all the simulator sessions. Ground-air inaccuracies accounted for 75 percent of all communication inaccuracies, and the single largest category of ground-air inaccuracy was the R-side "command" category, which made up more than half of all ground-air inaccuracies. A general pattern emerges when examining the total communication inaccuracies by team type. Table 3.4 lists the mean number of inaccuracies for the established teams. A comparison of these combined totals (in bold and underlined) with those of the new teams listed in Table 3.5 shows that the established teams generally had fewer communication inaccuracies than the new teams (with the exception of the expert/intermediate teams).

Table 3.4. Mean Communication Inaccuracies per Established Team Session

	EXP./EXP. EST			EXP./INT. EST			INT./INT. EST		
MODERATE	R-Side	D-Side	Total*	R-Side	D-Side	Total*	R-Side	D-Side	Total*
Ground-Air	7.0	.0	7.0	3.3	.0	3.3	2.5	.0	2.5
Ground-Line	1.0	1.8	2.8	.6	1.0	1.6	.5	1.3	1.8
TOTAL	8.0	1.8	9.8	3.9	1.0	4.9	3.0	1.3	4.3
HEAVY									
Ground-Air	3.5	.0	3.5	4.8	.0	4.8	5.3	.0	5.3
Ground-Line	.8	1.5	2.3	.4	1.0	1.4	.3	1.0	1.3
TOTAL	4.3	1.5	5.8	5.1	1.0	6.1	5.5	1.0	6.5
COMBINED									
Ground-Air	5.3	.0	5.3	4.0	.0	4.0	3.9	.0	3.9
Ground-Line	.9	1.6	2.5	.5	1.0	1.5	.4	1.1	1.5
TOTAL	6.1	1.6	**7.8**	4.5	1.0	**5.5**	4.3	1.1	**5.4**

* Note: Some totals do not add up exactly due to rounding.

COMMUNICATION INACCURACIES (Continued)

Table 3.5. Mean Communication Inaccuracies per New Team Session

	EXP./EXP. NEW			EXP./INT. NEW			INT./INT. NEW		
MODERATE	R-Side	D-Side	Total*	R-Side	D-Side	Total*	R-Side	D-Side	Total*
Ground-Air	10.5	.0	10.5	3	.0	3	4.0	.0	4.0
Ground-Line	.0	4.0	4.0	0.5	1.3	1.8	2.5	2.5	5.0
TOTAL	10.5	4.0	14.5	3.5	1.3	4.8	6.5	2.5	9.0
HEAVY									
Ground-Air	10.5	.0	10.5	5.3	.0	5.3	7.5	.0	7.5
Ground-Line	2.0	.0	2.0	0.3	1	1.3	2.0	2.0	4.0
TOTAL	12.5	.0	12.5	5.5	1	6.5	9.5	2.0	11.5
COMBINED									
Ground-Air	10.5	.0	10.5	3.9	0	3.9	5.8	.0	5.8
Ground-Line	1.0	2.0	3.0	0.4	1.1	1.5	2.3	2.3	4.5
TOTAL	11.5	2.0	13.5	4.3	1.1	5.4	8.0	2.3	10.3

* Note: Some totals do not add up exactly due to rounding.

A three-way ANOVA was carried out for total communication inaccuracies. The three factors were team type (eight team types), controller side (R-side and D-side), and workload (moderate and heavy). There was a significant main effect of team type ($F = 4.38$, $df = 7, 112$, $p < .05$) for total inaccuracies. A subsequent Duncan New Multiple Range test for multiple comparisons applied to the means associated with team type showed that the expert/intermediate teams (both established and new) had significantly fewer total communication inaccuracies than all other new team types including the novice/novice team types shown in Table 3.6.

COMMUNICATION INACCURACIES (Continued)

Table 3.6. Mean Communication Inaccuracies per Novice Team Session

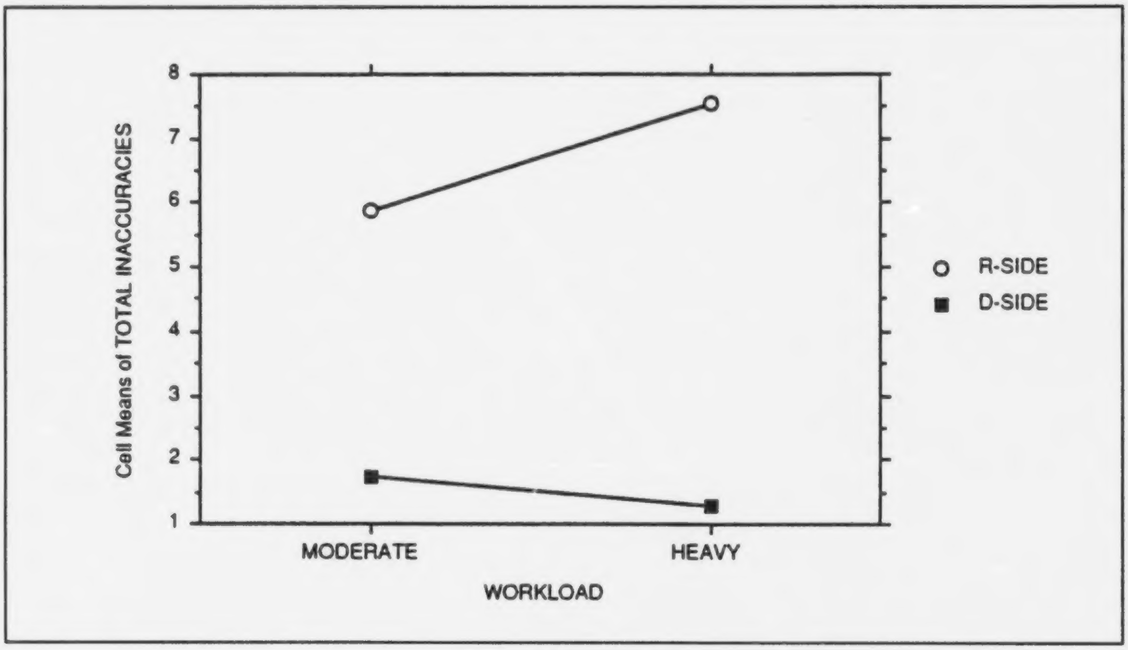
	NOVICE/NOVICE NEW				NOVICE/NOVICE 2ND NEW		
MODERATE	R-Side	D-Side	Total*		R-Side	D-Side	Total*
Ground-Air	5.6	.0	5.6		8.0	.0	8.0
Ground-Air	.4	2.4	2.8		1.0	1.0	2.0
TOTAL	6.0	2.4	8.4		9.0	1.0	10.0
HEAVY							
Ground-Air	10.0	.0	10.0		11.0	.0	11.0
Ground-Line	.5	1.3	1.8		.0	1.8	1.8
TOTAL	10.5	1.3	11.8		11.0	1.8	12.8
COMBINED							
Ground-Air	7.8	.0	7.8		9.5	.0	9.5
Ground-Line	.4	1.8	2.3		.5	1.4	1.9
TOTAL	8.3	1.8	**10.1**		10.0	1.4	**11.4**

* Note: Some totals do not add up exactly due to rounding.

There was a significant interaction between controller side and workload for total communication inaccuracies ($F = 4.13$, $df = 1, 112$, $p < .05$). A further analysis of that interaction shows the relationship illustrated in Figure 3.18 where the R-side controller has more inaccuracies under heavy workload while the D-side tends to have fewer. This interaction underscores two key points about communication inaccuracies. First, the R-side controller has more inaccuracies than the D-side controller under both moderate and heavy workload. This finding is to be expected since the R-side has more than twice the number of ground-air speech turns as compared with the number of D-side ground-line turns. Second, increase in workload has a greater negative effect on the communication accuracy of the R-side as compared to the D-side. With increased workload, the R-side has a greater number of communication inaccuracies, but there is no similar negative effect on the D-side.

COMMUNICATION INACCURACIES (Continued)

Figure 3.18. Interaction Plot of Side by Workload



IV. METHODS: LIVE TRAFFIC

PARTICIPANTS

The field data collection took place at the New York and Seattle ARTCC's. Controllers worked in two-person teams of radar controller and radar associate controller. Data from seven teams across the two Centers were analyzed for this study. Thus, there was a total of 14 participants.

The seven sessions were selected for three reasons: 1) They provided evidence of adequate-to-good overall performance as judged by three expert controllers; 2) Their volume of communication segments provided a reasonable balance between the New York and Seattle samples; and 3) Each of the sessions lasted from 45 to 60 minutes, thus providing a sample of adequate length to illustrate individual team communication characteristics.

The seven sessions from the field data collection were:

New York Center

New York Session 1	Sector 66
New York Session 2	Sector 66
New York Session 3	Sector 66
New York Session 4	Sector 25

Seattle Center

Seattle Session 1	Sector 6
Seattle Session 2	Sector 2
Seattle Session 4	Sector 2

The radar associate controller position in New York Center is the "H-side" (handoff) controller. These controllers are all FPL's of varying levels of experience. In contrast, the radar associate controller position in Seattle Center is the "D-side" (data) controller. These controllers are not necessarily FPL's.

Table 4.1 presents demographic data for the participants in the live-traffic study. The table contains information for all 14 controllers: their years of experience in the area in which they work; their years of experience as FPL's; and the years of experience that each team had working together.

PROCEDURES

Each of the seven controller teams managed live traffic in sector airspace for periods of 45 to 60 minutes. Permission to record these sessions was obtained beforehand from all participants. All sessions were videotaped and audiotaped. A single video camera captured both the controllers within its field of view. For most sessions, marking of flight strips could be observed on the videotapes, as well as controllers touching the land-line buttons to establish ground-line communication.

Table 4.1. Controller Experience

	Years of Experience in Area	**Years of Experience as FPL**	**Years of Experience on This Team**
New York Session 1			
R-Side	6	6	6
H-Side	6	6	
New York Session 2			
R-Side	9	5	5.5
H-Side	6	7	
New York Session 3			
R-Side	9	5	0.16
H-Side	0.25	6	
New York Session 4			
R-Side	20	15	1
H-Side	1	5	
Seattle Session 1			
R-Side	9.5	7.5	4
D-Side	7	4	
Seattle Session 2			
R-Side	6	3	6
D-Side	6	2	
Seattle Session 4			
R-Side	2.5	0	2.5
D-Side	3	0.33	

PROCEDURES (Continued)

Two separate audiotapes were made. The first tape captured radio communications between pilots and the R-side controller. The second tape captured all speech from both controllers. One notable handicap was the inability to capture the ground-line communication from other sectors during the New York data collection. This limitation affected the codability of some of the communication because context could not always be determined from one side of the conversation.

Following each taping session, both controllers answered questions about traffic volume, traffic complexity, equipment problems, weather factors, and special situations in the area. These data are presented in Table 4.2.

Obviously, traffic volume and complexity could not be controlled during the sessions, but the data collection team did attempt to record intervals of moderate to heavy workload. Variability in workload was also a result of the characteristics of sector airspace in terms of the type of traffic predominant in that sector. For example, New York Sector 66 controls a large number of aircraft descending and climbing to and from various approach controls, in addition to a handful of overflights. New York Sector 25 is primarily an arrival sector. Controller performance with live traffic is affected by these sector characteristics because they influence factors such as the need for coordination with other sectors and the types of control actions that are employed to manage the different types of traffic (e.g., arrivals, departures, overflights, or special operations).

PROCEDURES (Continued)

Table 4.2. Assessment by Controllers of Session Characteristics

	Sector	Traffic Volume Rating*	Traffic Complexity Rating**	Equipment Problems	Weather Factors	Situations in Area
New York Session 1						
R-Side	66	2.5	2.5	ACY radar	No	Warning Area Active
H-Side	66	2.5	2.5			
New York Session 2						
R-Side	66	3	3	ACY radar	No	None
H-Side	66	3	3.5			
New York Session 3						
R-Side	66	1	3.5	ACY radar	No	None
H-Side	66	1	2.5			
New York Session 4						
R-Side	25	3	1.9	None	No	None
H-Side	25	2	2			
Seattle Session 1						
R-Side	6	0.5	1.1	None	No	None
D-Side	6	0.6	0.8			
Seattle Session 2						
R-Side	2	2	4	New Metering	Strong Wind	None
D-Side	2	1.9	3.3			
Seattle Session 4						
R-Side	2	0.6	0.8	New Metering	No	TCM VOR 0TS,
D-Side	2	0.8	0.6			no military traffic

* Traffic volume was rated on a 5-point scale ranging from light to heavy.
** Traffic complexity was rated on a 5-point scale ranging from simple to complex.

CODING PROCEDURES

Controller communications from each session were transcribed from the two audiotapes into two transcripts: one for team communication and one for R-side radio communication. The team communication transcript was used to analyze ground-line communication as well as controller team communication.

These transcripts were separated into speech act segments within speech turns in the following ways. Communications were divided and coded into speech act units that correspond to "utterances serving one discourse function" (Morrow et al., 1990). Unlike the technique used by Morrow and his colleagues, however, this separating was done when the discourse function shifted within a speech turn. This approach to separation of speech act units within turns allowed a discrete mapping of the communication category to the portion of the speech turn for which it applied. The approach did not capture multiple instances of the same type of speech act when they occurred consecutively within a turn.

Each speech act segment was categorized by the following dimensions (see Appendix D for detailed descriptions of the categories and corresponding coding guidelines):

Speaker

Primary Receiving Agent—the person to whom the communication was directed.

Secondary Receiving Agent—communications that could be heard by the other controller team member. The two cases of interest are R-side communications to pilots and H/D-side communications to other sectors.

Communication Categories—The 16 categories used in the analysis were modifications based on categories presented by Foushee et al. (1986). These categories cover the range of discourse functions employed in en route air traffic control (e.g., acknowledgments, commands, inquiries into situation and intent, observations, statements of intent, etc.). The categories used and their abbreviations are as follows:

AC	Acknowledgment	II	Inquiry—Intent
AG	Agreement	IS	Inquiry—Situation
AS	Answer Supplying Information	NC	Noncodable
CAR	Command/Request Action	NT	Non-Task-Related
CC	Courtesy Comment	OB	Observation
CL	Clarify Response Comment	RP	Repetition
COR	Correcting Response	SI	Statement of Intent
DI	Disagreement	SUG	Suggestion

CODING PROCEDURES (Continued)

Controller Task Categories—These categories are based on the cognitive task analysis of en route air traffic control (Human Technology, 1990, 1991). The task categories describe the context within which each communication took place as part of a comprehensive goal structure for air traffic control tasks. Examples include primarily cognitive tasks, such as maintaining situation awareness and developing and revising plans, and primarily operational tasks, such as management of arrivals and departures, initiating and receiving handoffs, etc. The categories used and their abbreviations are as follows:

DP	Develop and Revise Sector Control Plan
IA	Issue Advisory
IH	Initiate Handoff
IP	Initiate Pointout
MA	Manage Arrivals
MD	Manage Departures
MO	Manage Overflights
MS	Maintain Situation Awareness
NC	Noncodable
RC	Resolve Aircraft Conflict
RH	Receive Handoff
RP	Receive Pointout
RR	Reroute Aircraft

Two coders were trained in the use of codes for the communication categories and task categories. Rules and guidelines were developed to clarify the application of the codes. Tests of intercoder reliability showed 88 percent agreement for communication coding and 91 percent agreement for task coding. An expert controller reviewer contributed to the task coding by explaining the dynamic context of the sessions.

ANALYSIS

The live traffic analyses examined radar controller and radar associate controller communication in terms of the following three types of interactions:

- Team Communication—communication between the radar controller and the radar associate controller within the same sector.
- Ground-Air Communication—communication from the radar controller to pilots.
- Ground-Line Communication—communication from the radar associate controller (and occasionally from the radar controller) to controllers in other sectors.

The communication data were partitioned according to speaker (radar controller or radar associate controller). Thus, the basic data were organized into 28 groups as follows:

- Type of interaction and speaker—4 groups
  a. Team—R-side to H/D-side
  b. Team—H/D-side to R-side
  c. Ground-air
  d. Ground-line
- Session—7 sessions (4 in New York and 3 in Seattle)

For each of the 28 groups of data, frequency percentages were computed for the following categories and combinations of categories:

- Communication Category (16 categories)
- Controller Task Category (13 categories)
- The interaction between Communication Category and Controller Task Category

The live traffic data analyses were primarily descriptive analyses examining differences in patterns of communication and task categories in different types of controller communication (i.e., team, ground-air, and ground-line). The primary descriptive statistic computed was the frequency of communication category or task category as a percentage of the total number of speech acts of the type being examined in the session. For example, if there were 10 observations out of a total of 100 R-side to H-side speech acts in the New York Session 1, then observations would account for 10 percent of the R-side to H-side controller team communication.

ANALYSIS (Continued)

Because the seven sessions differed on a number of criteria, differences among sessions and centers are described when they occur.

Statistical tests were conducted to support the descriptive analyses whenever a difference was predicted based on past research or theoretical grounds or when examination of the descriptive data revealed a potential difference of interest.

V. RESULTS: LIVE TRAFFIC

INTRODUCTION

This section of the report presents the results of the live traffic analyses. First, the data sample is summarized. Next, the controller team communications are discussed. Finally, the ground-air and ground-line results are presented.

The raw data on frequency of communication categories, controller task categories, and communication-by-task interactions for each of the 28 groups of data are provided in Appendix E. Tables of the statistical analyses of the data are also presented in Appendix E.

Particular emphasis was placed on the following relationships:

- Differences between radar controllers and radar associate controllers in the frequency of use of specific communication categories and controller task categories.
- Differences in frequency of communication categories and controller task categories in the controller side of ground-air and ground-line communications.

SUMMARY OF COMMUNICATION AND SECTOR CHARACTERISTICS FOR THE DATA SAMPLE

The live traffic analyses included 2,847 speech act units from the seven sessions recorded. Table 5.1 contains the number of speech act units for each session and speaker in the team. (Note: Speech acts were identified based on discourse function shifts, and, therefore, multiple speech acts of the same type are treated as a single unit for this analysis.)

Table 5.1. Summary Descriptive Data by Session

Session	Number of Speech Act Units			No. of Aircraft (approx.)	Session Length	Comm. Per Min.
	Radar (R-Side)	Associate (H/D-side)	Total			
New York 1	389	181	570	39	60 min.	9.50
New York 2	299	113	412	23	45 min.	9.16
New York 3	220	121	341	34	60 min.	5.68
New York 4	170	53	223	24	45 min.	4.96
Seattle 1	163	55	218	30	60 min.	3.63
Seattle 2	484	241	725	30	60 min.	12.08
Seattle 4	246	112	358	15	45 min.	7.96
Totals	1,971	876	2,847			

SUMMARY OF COMMUNICATION AND SECTOR CHARACTERISTICS FOR THE DATA SAMPLE (Continued)

The counts in Table 5.1 include the speech act units that were found to be noncodable or non-task-related for communication categories and noncodable for task categories.

Table 5.1 also contains approximate counts of aircraft dealt with during each session. These counts are based on flight strip data obtained from the sessions. Approximate length in minutes is listed per session. The last column gives an index of average communication volume over the course of the session (calculated as the ratio of total number of communication units to length of the session). However, this measure does not reflect the clustering of traffic levels during the course of the sessions, and thus does not characterize traffic volume or complexity.

Since sector characteristics vary in this live traffic study, it is important to provide a description of each sector's characteristics that might lead to differences in communication patterns. Certain differences emerge among the types of sector and sector traffic for the data sample. The first three New York sessions were taped in sector 66. Traffic in this sector is composed of arrivals and departures through primarily a midaltitude range (10,000 to 23,000 feet). Traffic flow was uneven, creating periods of intense activity. This traffic is relatively more complex than that experienced in New York Session 4 in Sector 25. In sector 25, most aircraft were arrivals.

The expert controller who reviewed the videotapes commented that phraseology was poor overall in the first three New York sessions. Many statements were indecipherable as to controller tasks, indicative of the problems that can be caused with nonstandard or incomplete controller statements. In contrast, New York Session 4 offered much clearer communication because of better phraseology.

Seattle Session 1 took place in Sector 6, while the other two Seattle sessions were recorded in Sector 2. These sectors were midrange altitude (up to 23,000 feet), though they sometimes owned all the airspace down to the ground. In Seattle Session 1, traffic was of low complexity. Many aircraft traveled between Eugene and Portland, Oregon, thus departing and landing within the same sector. Traffic flow was even, resulting in no "pushes" of traffic.

Seattle Session 2 was complicated by a number of factors: A Boeing jet used a block of altitude for test maneuvering; a Flightcheck was maneuvering in and out of the sector to check a VOR, affecting all arrivals for the sector; and a new metering system provoked a protracted conversation by the controller team.

Seattle Session 4 had the controller team with the least amount of FPL experience (0.33 years overall). One notable characteristic of the communication style of this team was that they spent more time explicitly planning than the other teams in the study.

CONTROLLER TEAM COMMUNICATION

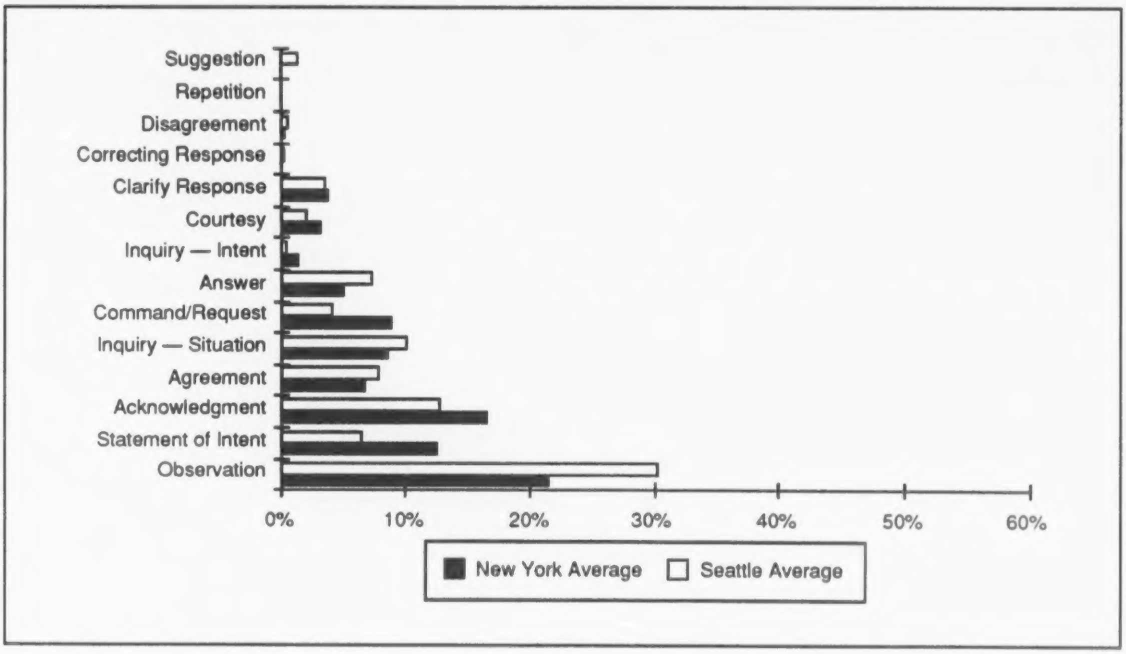
The first two subsections of the controller team communication results section present the analyses of the Communication and Controller Task data. The third subsection explores the interaction between Communication and Task categories. The fourth subsection of the team communication results section presents a description of effectiveness of communications by comparing two different sessions.

COMMUNICATION CATEGORIES

Radar Controller Communication

Figure 5.1 shows the frequency percentages of R-side team communication categories by center. Table 5.2 shows the frequency percentages of each communication category for team communication (R-side to Radar Associate) for each session.

Figure 5.1. R-Side Team Communication by Center



Radar Controller Communication (Continued)

Table 5.2. R-Side to Radar Associate Communication Category Frequency Percentages by Session

	NY1	NY2	NY3	NY4	SEA1	SEA2	SEA4
Acknowledgment	8.5	29.6	12.2	15.4	14.6	13.8	9.8
Agreement	7.4	9.3	10.2	0.0	2.4	12.8	7.8
Answer	5.3	5.6	8.2	0.0	7.3	6.4	7.8
Command/Request	11.7	7.4	8.2	7.7	9.8	2.3	0.0
Courtesy Comment	2.1	0.0	10.2	0.0	2.4	1.8	2.0
Clarify Response	1.1	0.0	6.1	7.7	4.9	1.8	3.9
Correcting Response	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Disagreement	1.1	0.0	0.0	0.0	0.0	0.9	1.0
Inquiry—Intent	1.1	0.0	4.1	0.0	0.0	0.5	1.0
Inquiry—Situation	8.5	9.3	8.2	7.7	2.4	15.6	11.8
Noncodable	9.6	7.4	6.1	7.7	0.0	1.4	1.0
Non-Task-Related	11.7	7.4	2.0	0.0	22.0	3.7	12.7
Observation	28.7	18.5	22.4	15.4	29.3	30.7	30.4
Repetition	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Statement of Intent	3.2	5.6	2.0	38.5	4.9	6.9	7.8
Suggestion	0.0	0.0	0.0	0.0	0.0	0.9	2.9

For the radar controller speaking to the radar associate controller, "observation" is the most common category, ranging from 15 to 30 percent of the R-side communications. Radar controller observations are key in maintaining situation awareness and developing plans, the two task categories that are most frequently represented (see next subsection). The significance of this result is discussed further in the section on the interaction between communication and task categories.

Other communication categories are used frequently by the radar controller in team communication. The ranges of these frequency percentages for the seven teams are as follows: "statement of intent" (2 - 38 percent), "acknowledgment" (8 - 29 percent), "agreement" (0 - 12 percent), "inquiry—situation" (2 - 15 percent), "command/request" (0 - 11 percent), and "answer" (0 - 8 percent).

In two of the seven sessions, "observation" is not the most frequent category of R-side communication. First, in New York Session 4, the largest percentage is in the "statement of intent" category (38 percent). This large percentage is due in part to the low total number of communications from the R-side to H-side (n = 13).

Radar Controller Communication (Continued)

Second, in New York Session 2, the largest percentage is for "acknowledgment." It is interesting to note that the H-side controller in this team has the highest percentage of observations (see Table 5.3). It is likely that the high percentage of R-side acknowledgments results from responding to these observations made by the radar associate controller. This pattern of interaction may simply reflect individual differences. Other characteristics of this team (i.e., New York Session 2) are that the H-side controller has two more years of FPL experience than does the R-side controller, and that this H-side controller submitted the highest rating of traffic complexity for this session (3.5 on a scale of 0-5).

"Command/request" from the radar controller to the radar associate controller never ranks the highest among the communication categories. Thus, unlike cockpit crews, the R-side controller does not appear to set the priorities for the team at all times. This point will be discussed further in the subsection on the interaction between communication and tasks.

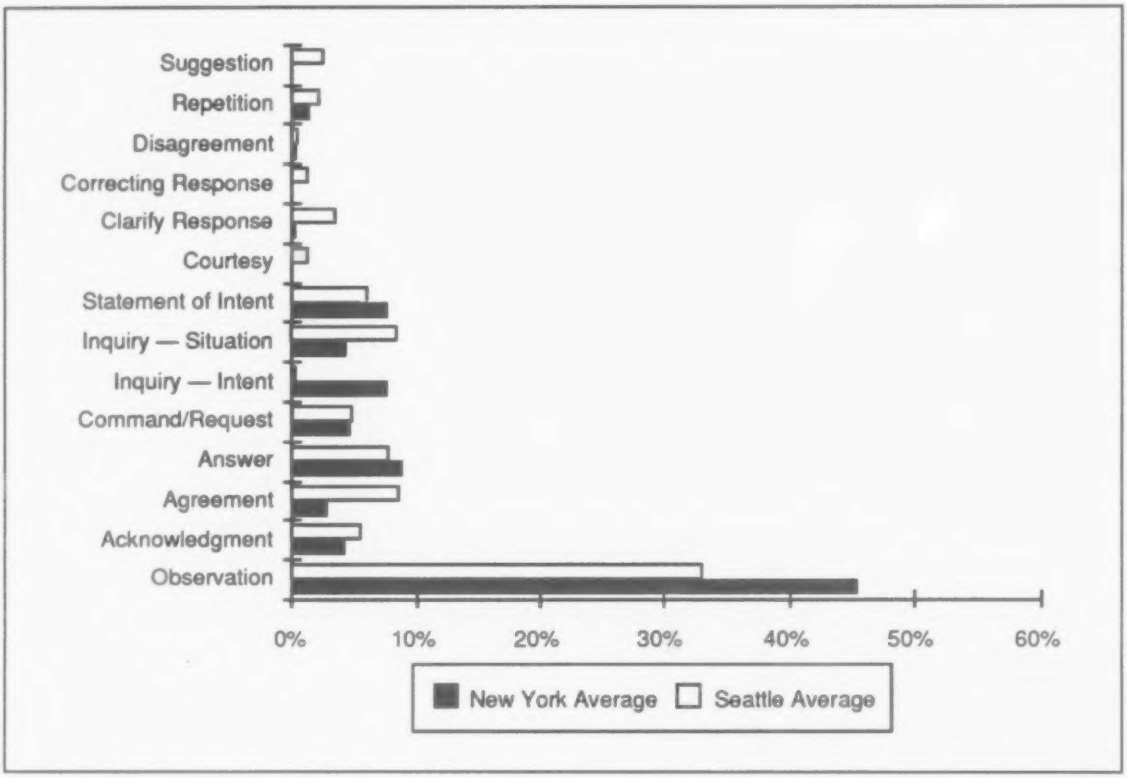
The radar controllers in Seattle teams 2 and 4 used "inquiry into situation" at somewhat higher levels than the R-side controllers in the other teams. During these two sessions, the teams were spending a fair amount of time learning how to work with a new metering system. This element of the situation may account for the larger than usual percentages of R-side "inquiry—situation."

Radar Associate Controller Communication

The radar associate communication percentages for the New York and Seattle Centers are illustrated in Figure 5.2 and listed in Table 5.3. The frequencies of communication categories when the radar associate controller is addressing the radar controller are somewhat different from the category frequencies when the radar controller is addressing the radar associate controller. "Observation" is always the highest radar associate communication category, ranging from 29 to 53 percent. The large percentages of observations are in contrast to the observation percentage range for the R-side controllers (15 to 30 percent). On average, the radar associate controllers use observation approximately 40 percent of the time during team communication, while radar controllers use observation approximately 25 percent of the time during team communication.

Radar Associate Controller Communication (Continued)

Figure 5.2. Radar Associate Team Communication by Center



Radar Associate Controller Communication (Continued)

Table 5.3. Radar Associate to R-Side Communication Category Frequency Percentages By Session

	NY1	NY2	NY3	NY4	SEA1	SEA2	SEA4
Acknowledgment	4.2	3.7	3.6	5.0	14.6	1.5	0.0
Agreement	2.1	0.0	9.1	0.0	2.4	11.9	11.1
Answer	8.4	9.3	7.3	10.0	7.3	9.3	6.7
Command/Request	2.1	0.0	1.8	15.0	9.8	3.6	1.1
Courtesy Comment	0.0	0.0	0.0	0.0	2.4	0.5	1.1
Clarify Response	1.1	0.0	0.0	0.0	4.9	4.1	2.2
Correcting Response	0.0	0.0	0.0	0.0	0.0	0.5	3.3
Disagreement	1.1	0.0	0.0	0.0	0.0	0.5	1.1
Inquiry—Intent	2.1	3.7	10.9	15.0	0.0	1.0	0.0
Inquiry—Situation	9.5	3.7	3.6	0.0	2.4	9.3	13.3
Noncodable	16.8	9.3	9.1	5.0	2.4	2.1	6.7
Non-Task-Related	4.2	3.7	3.6	0.0	17.1	2.1	12.2
Observation	44.2	53.7	41.8	40.0	29.3	37.1	32.2
Repetition	1.1	0.0	0.0	5.0	4.9	0.5	1.1
Statement of Intent	3.2	13.0	9.1	5.0	2.4	9.3	6.7
Suggestion	0.0	0.0	0.0	0.0	0.0	6.7	1.1

The ranges for the other major categories of radar associate communication are: "acknowledgment" (0 - 14 percent); "agreement" (0 - 11 percent); "answer" (6 - 10 percent); "command/request" (0 - 15 percent); "inquiry into intent" (0 - 15 percent); "inquiry into situation" (0 - 13 percent); and "statement of intent" (2 - 13 percent). Infrequently occurring categories (less than 7 percent maximum for any session) are "courtesy comment," "clarification," "correction," "disagreement," "repetition," and "suggestion." There is a large amount of variability in the relative percentages beyond the observation category; these differences most likely reflect various aspects of team dynamics for the individual teams and the nature of traffic volume and complexity during the individual sessions.

"Acknowledgment" (17 percent) and "command/request" (9 percent) are the second and third highest task-related categories in Seattle Session 1. These large percentages are attributable in part to the small overall size of the data sample in this session. It is interesting to note that if one looks at the sum of three of the categories that are responses—"acknowledgment," "agreement," and "answer"—Seattle Session 1 has the highest percentage among the seven sessions in the study, 24 percent. Because there is a high level of responses for this D-side controller, it means that the R-side controller is initiating discussions. Also this D-side controller has relatively high levels of "clarification" and "repetition." This latter finding suggests that this team had a problem with the timing of communications.

Radar Associate Controller Communication (Continued)

New York Center uses an H-side as the radar associate controller, while Seattle Center uses a D-side. To investigate whether there were significant differences in communication categories based on this difference, statistical tests were performed on the categories for radar associate controller team communication by center. There were three statistically significant differences between New York and Seattle. Seattle D-side controllers made more courtesy comments, more clarifications, and fewer observations than did New York H-side controllers. Appendix E contains the detailed results of the statistical tests performed on the radar associate team communication categories.

Comparison of Radar Controller and Radar Associate Controller Communication

Table 5.4 shows the frequency percentages of the most frequent communication categories by position and by center. To test for differences between radar controllers and radar associate controllers, a Position by Center (2 by 2) ANOVA was computed for each of the communication categories. Appendix E contains the complete ANOVA results.

Table 5.4. Radar Controller and Radar Associate Controller Major Communication Category Frequency Percentages

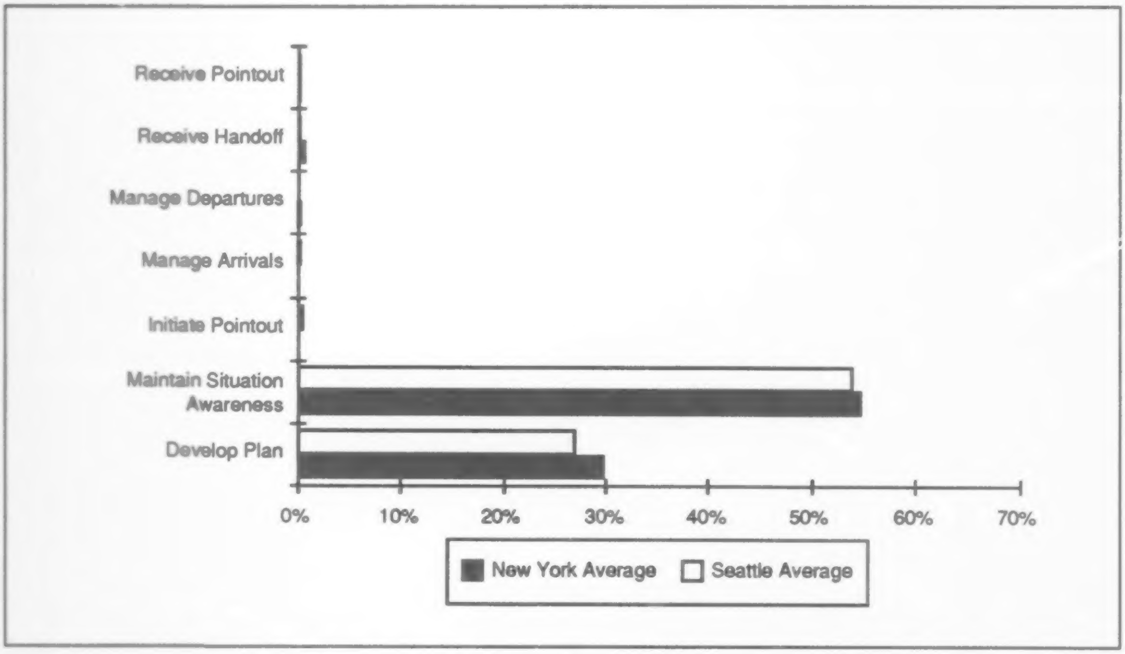
Communication Category	R-Side/NY	R-Side/Seattle	H-Side/NY	D-Side/Seattle
Acknowledgment	16.4	12.7	4.1	5.4
Agreement	6.7	7.7	2.8	8.5
Answer	4.8	7.2	8.7	7.8
Command/Request	8.7	4.0	4.7	4.8
Courtesy Command	3.1	2.1	0.0	1.4
Clarify Response	3.7	3.5	0.3	3.7
Inquiry—Intent	1.3	0.5	7.9	0.3
Inquiry—Situation	8.4	9.9	4.2	8.4
Noncodable	7.7	0.8	10.0	3.7
Non-Task-Related	5.3	12.8	2.9	10.5
Observation	21.3	30.1	44.9	32.9
Statement of Intent	12.3	6.5	7.6	6.1

Significant differences for position were found for "observation" ($F = 24.67$, $df = 1, 10$, $p < .05$) and "acknowledgment" ($F = 8.31$, $df = 1, 10$, $p < .05$). Radar associate controllers made more observations than did radar controllers, with the difference greater in New York than in Seattle ($F = 15.51$, $df = 1, 10$, $p < .05$). Radar controllers gave more acknowledgments than did radar associate controllers.

CONTROLLER TASK FREQUENCIES

The task frequency analysis for team communication yields one of the most interesting results of the entire study: the tasks Maintain Situation Awareness (MS) and Develop and Revise Sector Control Plan (DP) dominate these team interactions, accounting for more than 80 percent of all communications (see Figure 5.3). This result is of interest because, of the 12 major tasks derived from the cognitive task analysis of en route air traffic control (Human Technology, 1990, 1991), these two tasks are the primarily cognitive ones. This present result provides cross validation of the importance of these two tasks. When a radar controller works a sector alone, verbal evidence of these tasks is present only in ground-line and ground-air communications. The analyses of ground-line and ground-air communications show proportionally much less of these two tasks because the major function of ground-line and ground-air communications is to implement control plans and actions within the operational tasks. This team communication analysis reveals that when the radar controller and radar associate controller are functioning as a team, they develop shared understanding of the situation and their plan for sector control; and they must communicate to achieve that shared understanding. The results on task frequency for ground-line and ground-air communication (presented later in this report) show a very different pattern. Specifically, ground-line and ground-air communications support these two cognitive tasks a much smaller percentage of the time.

Figure 5.3. Task Frequency Percentages for Team Communication by Center



CONTROLLER TASK FREQUENCIES (Continued)

The only other tasks present in team communication were: Initiate Pointout (IP), Manage Arrivals (MA), Manage Departures (MD), Resolve Conflict (RC), Receive Handoff (RH), and Receive Pointout (RP). The assignments of these task categories to these small numbers of communications were based on the discriminations of the expert controller reviewer. The task frequency percentages are listed in Table 5.5 for the two ARTCC's (noncodable communications accounted for the remaining percentages).

Table 5.5. Frequency Percentages for Controller Tasks: Means for New York and Seattle Centers

Center	DP	MS	IP	MA	MD	RC	RH	RP
New York	29.8	54.0	0.0	0.0	0.1	0.0	0.6	0.2
Seattle	26.7	53.1	0.4	0.1	0.0	0.1	0.1	0.2
Average %	28.3	53.6	0.2	0.0	0.1	0.0	0.4	0.2

THE INTERACTION BETWEEN COMMUNICATION AND TASK CATEGORIES

In order to explore the co-occurrence between the communication categories and the two major cognitive tasks (Maintain Situation Awareness (MS) and Develop and Revise Sector Control Plan (DP)), frequency percentage matrices were constructed to show the distribution of communication categories across these two tasks (see Tables 5.6 and 5.7). The frequency percentage for each cell in the matrices represents the fraction of that particular communication category over the total amount of communication across both tasks. For example, if there were 500 communications in the MS and DP categories in New York Center for the R-side controller, and 50 of these communications were commands/requests for DP, then the matrix cell for commands/requests under DP would read 10 percent. This way of organizing the data shows the types of communication that support these two cognitive tasks.

Table 5.6 displays the frequency percentages for interactions between the communication categories and the task Develop and Revise Sector Control Plan (DP). The left half of the matrix is the R-side communication; the right half of the matrix is the radar associate controller communication. Table 5.7 displays the same information for the task Maintain Situation Awareness (MS). The percentages in the two tables reveal the relative frequency of each communication category across the two cognitive tasks.

THE INTERACTION BETWEEN COMMUNICATION AND TASK CATEGORIES (Continued)

A comparison of the percentages in Table 5.6, the DP data, shows that "observation" and "statement of intent" occur with higher frequency compared to the other communication categories. On average, both the radar controllers and the radar associate controllers used observations and statements of intent as the primary means of communicating about the development or revision of sector control plans. The one exception is that the radar controllers in New York Center used command/request fairly frequently to communicate about sector control plans.

Table 5.6. Communication Categories by Task Interactions for Develop and Revise Sector Control Plan (DP)

Communication Category	R-Side			Associate		
	Average NY	Average Seattle	Average Overall	Average NY	Average Seattle	Average Overall
Acknowledgment	4.8	3.6	4.2	3.3	0.4	1.8
Agreement	3.0	4.9	3.9	0.5	4.0	2.3
Answer	3.0	2.6	2.8	2.2	1.4	1.8
Command/Request	10.1	1.9	6.0	0.0	2.2	1.1
Courtesy Comment	0.6	0.6	0.6	0.0	0.4	0.2
Clarify Response	0.6	0.3	0.5	0.0	0.4	0.2
Correcting Response	0.0	0.3	0.2	0.0	1.1	0.5
Disagreement	0.0	0.3	0.2	0.5	0.4	0.5
Inquiry—Intent	1.2	0.6	0.9	6.0	0.4	3.2
Inquiry—Situation	1.2	3.6	2.4	1.1	3.6	2.4
Noncodable	0.0	0.0	0.0	0.0	0.0	0.0
Non-Task-Related	0.0	0.0	0.0	0.5	0.0	0.3
Observation	7.1	12.0	9.6	6.6	6.5	6.5
Repetition	0.0	0.0	0.0	0.0	0.7	0.4
Statement of Intent	7.1	7.8	7.5	7.7	7.9	7.8
Suggestion	0.0	1.0	0.5	0.0	2.9	1.4

THE INTERACTION BETWEEN COMMUNICATION AND TASK CATEGORIES (Continued)

A comparison of the values in Table 5.7 leads to several conclusions about controllers' use of communication in maintaining situational awareness (MS). Controllers used far more "observations" than any other category in communicating about situational awareness. This finding is consistent across both Centers and both positions (R-side and D/H-side). "Inquiry into situation" is the second most frequently used form of communication to help maintain situational awareness. Therefore, "observation" and "inquiry—situation" are the two most frequently used forms of communication in maintaining situation awareness.

Table 5.7 also reveals the complementary pattern between radar controllers and radar associate controllers in regard to maintaining situational awareness. The radar associate controllers make more observations and the radar controllers give more acknowledgments.

THE INTERACTION BETWEEN COMMUNICATION AND TASK CATEGORIES (Continued)

Table 5.7. Communication Categories by Task Interactions for Maintain Situation Awareness (MS)

Communication Category	R-Side			Associate		
	Average NY	Average Seattle	Average Overall	Average NY	Average Seattle	Average Overall
Acknowledgment	13.7	8.4	11.1	1.1	0.4	0.7
Agreement	6.0	7.1	6.5	3.3	7.9	5.6
Answer	3.6	5.2	4.4	7.7	8.3	8.0
Command/Request	1.8	0.3	1.1	3.3	2.2	2.7
Courtesy Comment	1.8	1.0	1.4	0.0	0.4	0.2
Clarify Response	2.4	2.6	2.5	0.5	3.2	1.9
Correcting Response	0.0	0.0	0.0	0.0	0.4	0.2
Disagreement	0.6	0.6	0.6	0.0	0.4	0.2
Inquiry—Intent	0.6	0.0	0.3	0.5	0.4	0.5
Inquiry—Situation	9.5	11.7	10.6	6.0	7.6	6.8
Noncodable	0.6	0.0	0.3	0.0	0.0	0.0
Non-Task-Related	0.0	0.0	0.0	0.0	0.0	0.0
Observation	20.8	23.0	21.9	47.0	32.9	39.9
Repetition	0.0	0.0	0.0	1.1	0.7	0.9
Statement of Intent	0.0	0.3	0.2	1.1	1.1	1.1
Suggestion	0.0	0.3	0.2	0.0	2.2	1.1

A more detailed analysis of the individual teams showed that, in addition to observations and statements of intent, most radar controllers used commands/requests to develop plans (DP) whereas only two of the seven radar associates did so. This pattern was not present in Seattle Session 4, the team with the smallest amount of FPL experience across both Centers.

THE INTERACTION BETWEEN COMMUNICATION AND TASK CATEGORIES (Continued)

Examination of the individual team data further revealed that the teams differed in their use of observations. The ratio of observations used for DP versus observations used for MS indicated that experience affected the use of this communication category for these tasks (see table 5.8). The team with the most FPL experience used no observations to plan, and in general, the more experienced teams used observations more to maintain situation awareness than to plan. The team with the smallest amount of FPL experience, Seattle Session 4, had the highest ratio, indicating the most use of observations for planning.

Table 5.8. Use of Observation in Controller Tasks

Team	Mean Ratio of OB(DP) to OB(MS) for Teams	Mean Years of FPL Experience	Salient Team Characteristic
New York 1	0.179	6.0	
New York 2	0.458	6.0	
New York 3	0.097	5.5	
New York 4	0.000	10.0	Highest average FPL experience
Seattle 1	0.091	5.75	
Seattle 2	0.227	2.5	
Seattle 4	0.933	0.167	Lowest average FPL experience

There was a significant negative correlation (r = -77) between ratio of observations and FPL experience, further suggesting that less experienced controllers were more likely to use observations to develop and refine plans as compared to their more experienced counterparts. The more experienced controllers were more likely to use observations to help maintain situational awareness.

COMPARISON BETWEEN SESSIONS

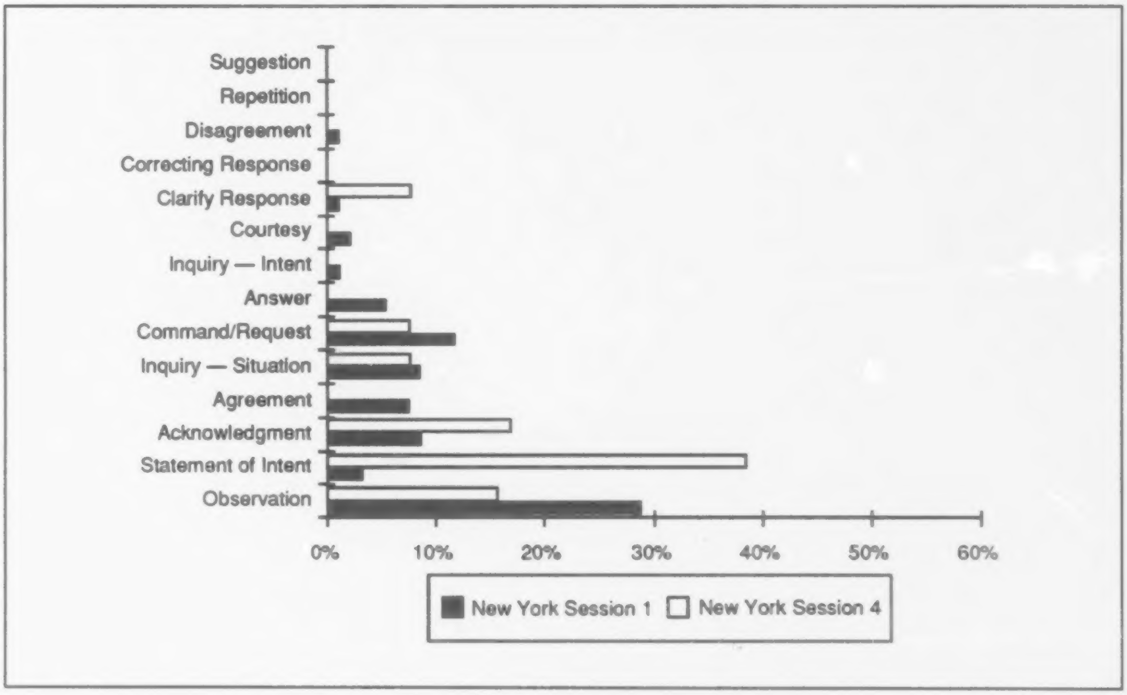
This subsection contains a description of differences between two live traffic sessions to emphasize the characteristics of effective controller communication. The two sessions are New York Session 1 and New York Session 4. New York Session 1 was rated by the expert controller reviewer as having poor phraseology and many incomplete statements. This session also contained instances of poor coordination between the H-side and other sectors. For instance, the H-side failed to obtain correct information from another sector about the computer ID for an aircraft, resulting in some confusion about the situation and requiring the H-side to call back. In contrast, New York Session 4 demonstrated more standard phraseology and complete statements, and operations ran more smoothly than in New York Session 1.

COMPARISON BETWEEN SESSIONS (Continued)

Subjective assessments by the controllers in these sessions showed that they rated traffic volume essentially the same for the two sessions. Both sessions were rated at 2.5 on a scale of 0-5. The controllers rated complexity somewhat differently with New York Session 1 = 2.5 and New York Session 4 = 1.95 on a scale of 0-5. The assessments overall show that New York Session 1 was slightly more complex than New York Session 4. The effect of complexity on workload would suggest, therefore, that New York Session 1 was somewhat more demanding than New York Session 4.

The communication categories breakdown for R-side and H-side as speaker in these two sessions is shown in Figures 5.4 and 5.5 (see also Tables 5.2 and 5.3 earlier in this section).

Figure 5.4. R-Side Communication, New York Session 1 (black bars) Versus New York Session 4 (white bars)

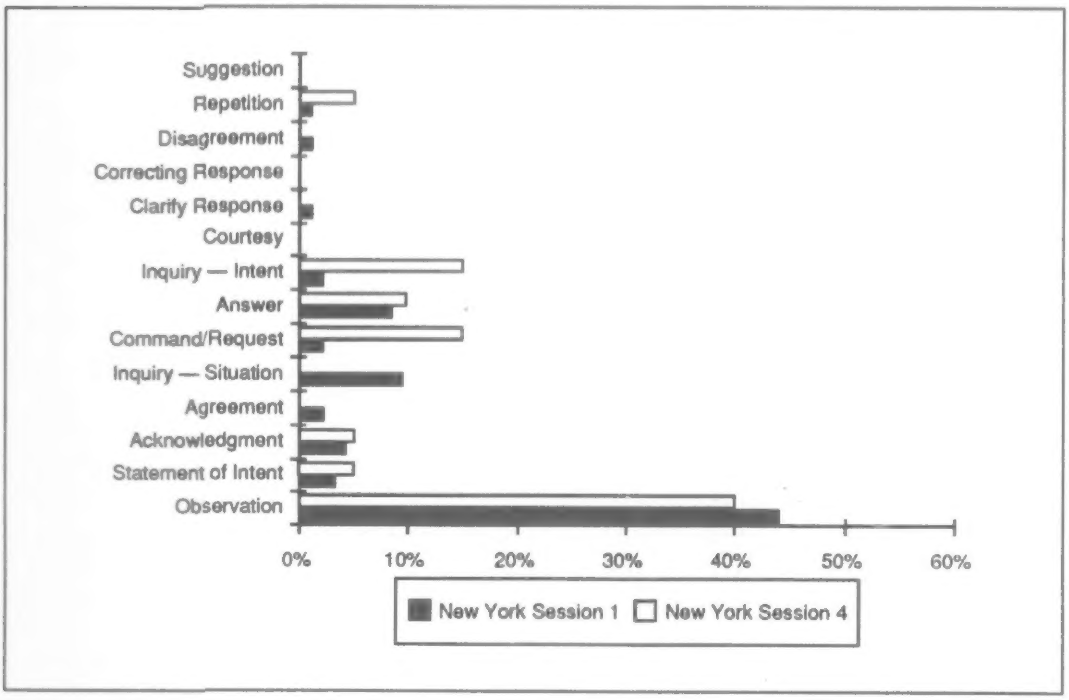


COMPARISON BETWEEN SESSIONS (Continued)

The differences between the two sessions were as follows:

- The R-side controller in New York Session 1 used more observations, commands, agreements, answers, inquiries into intent and situation, courtesy comments, and disagreements.
- The R-side controller in New York Session 4 used many more statements of intent and, to a lesser degree, more clarifications and acknowledgments.
- On the H-side, the New York Session 1 controller used more observations than his Session 4 counterpart. The Session 1 H-side controller also used more inquiries into situation, clarifications, and disagreements.
- The H-side controller from New York Session 4 used more commands/requests, inquiries into intent, and repetition.

Figure 5.5. H-Side Communication, New York Session 1 (black bars) Versus New York Session 4 (white bars)



COMPARISON BETWEEN SESSIONS (Continued)

The pattern of communication in New York Session 1 shows a greater variety of communication categories. With the greater number of observations, answers, inquiries into the situation, and disagreements, it appears that more discussion of the situation occurred in this session. In contrast, the pattern of interaction in New York Session 4 shows a more focused use of communication categories such as statements of intent on the part of the R-side controller and commands/requests and inquiries meant to elicit specific information about intent on the part of the H-side controller.

In sum, the New York Session 1 controllers discussed the situation more and also had an "observational" approach to communication. The New York Session 4 controllers were more focused and "negotiated" less about sector understanding and planning. It is of interest to note that the R-side controller in Session 4 had the largest number of years of FPL experience (15 years).

In light of the expert controller assessment of these two teams, poor communication behavior is associated with the less-directed, debating approach of New York Session 1. Better communication is associated with the more focused, less chatty pattern of New York Session 4. Average FPL experience was higher, and experience working as a team was lower, in the team with better communication.

The expert controller reviewer characterized poor team communication by the following three symptoms:

1. Whenever the radar controller or radar associate controller repeats a command or request or has to call back to another sector, that controller probably spoke when it was inappropriate, and the communication was ineffective.
2. Bad phraseology causes miscommunication.
3. Incomplete sentences cause miscommunication.

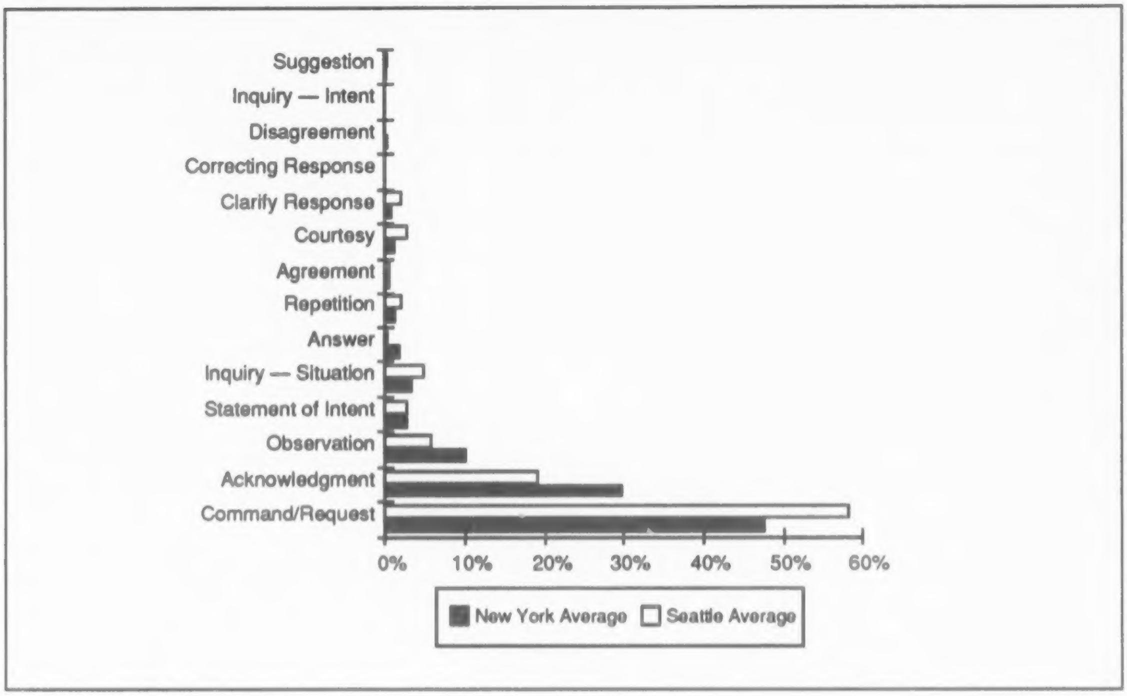
These symptoms indicate that some of the critical dimensions of effective team communication are timing, word choice, and completeness.

GROUND-AIR COMMUNICATIONS

Ground-air communication takes place between the R-side controller and aircraft pilots. Figure 5.6 and Table 5.9 present the data for this portion of the analysis. The dominant communication category was "command/request" (52.06 percent) and the second highest category was "acknowledgment" (25.06 percent), with "observation" the third highest category (8.41 percent). The communication category "inquiry—situation" occurred 3.91 percent of the time, and the category "statement of intent" occurred in 2.79 percent of the communications. The rest of the categories occurred in less than 2 percent of the communications in the sessions.

GROUND-AIR COMMUNICATIONS (Continued)

Figure 5.6. Ground-Air Communication Categories by Center



GROUND-AIR COMMUNICATIONS (Continued)

Table 5.9. Ground-Air Communication Category Frequency Percentages for Each Session

	NY1	NY2	NY3	NY4	SEA1	SEA2	SEA4
Acknowledgment	27.8	33.6	19.5	36.3	22.2	20.2	15.8
Agreement	1.4	0.9	0.0	0.0	0.0	1.7	0.0
Answer	1.8	2.6	3.0	0.0	0.0	0.4	0.8
Command/Request	51.4	41.3	52.7	45.2	66.7	48.5	58.6
Courtesy Comment	0.7	0.4	3.6	0.6	0.9	4.7	3.0
Clarify Response	1.8	0.9	0.0	0.6	0.9	3.4	3.0
Correcting Response	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disagreement	0.4	1.3	0.0	0.6	0.0	0.0	0.0
Inquiry—Intent	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Inquiry—Situation	2.8	1.7	4.7	3.2	2.6	9.4	3.0
Noncodable	0.0	0.0	0.6	0.6	0.0	0.4	0.0
Non-Task-Related	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Observation	8.5	12.3	10.7	9.6	2.6	6.9	8.3
Repetition	0.4	1.7	2.4	1.3	1.7	3.0	1.5
Statement of Intent	3.2	3.0	3.0	1.9	2.6	1.3	4.5
Suggestion	0.0	0.4	0.0	0.0	0.0	0.0	0.8

Statistical tests for differences between Centers for each communication category revealed no significant differences between Centers on any of the ground-air communication categories.

In general, the R-side controllers in both Centers interacted with pilots in a similar fashion. This homogeneity of communication patterns reflects, at least in part, that a well-defined structure of interaction with pilots is in place in the en route environment. Efficient practices included use of "statement of intent" to inform pilots when they could expect routing or altitude changes. Providing pilots with this information cuts down on dialogue with pilots. Providing pilots with information regarding vectoring also cuts down on unnecessary dialogue.

This ground-air pattern of communication is in sharp contrast to team communication and somewhat different from ground-line communication. The abundance of "command/request" and "acknowledgment" reflects the role of the R-side controller as the initiator of most communications. "Observation" and "statement of intent" are used to diminish dialogue with pilots. Team communication and ground-line communication, in contrast, do not reveal the R-side controller as the primary initiator of communication. Also, particularly in team interactions, the evidence indicates that patterns of team communication include more response categories (e.g., "acknowledgment," "answer," and "agreement"). This finding indicates that discussions are part of the process in communicating about plans and sharing knowledge about the situation.

Ground-Air Tasks

On initial inspection of the task data for each session (see Table 5.10) and the means for each Center (see Figure 5.7), it is evident that there were very few differences between Centers or sessions and that the bulk of ground-air controller tasks were the operational tasks. These tasks are listed in decreasing order of occurrence below. The percentages in parentheses are the average percentages across both Centers (noncodable communications accounted for the remaining percentage).

Manage Arrivals (20.85 percent)
Initiate Handoff (13.93 percent)
Manage Departures (13.16 percent)
Receive Handoff (12.74 percent)
Resolve Conflict (9.47 percent)
Maintain Situation Awareness (7.59 percent)
Reroute Aircraft (3.66 percent)
Issue Advisory (2.74 percent)
Manage Overflights (0.06 percent)

The other three tasks—develop and revise sector plan, initiate pointout, and receive pointout—do not occur in this body of data.

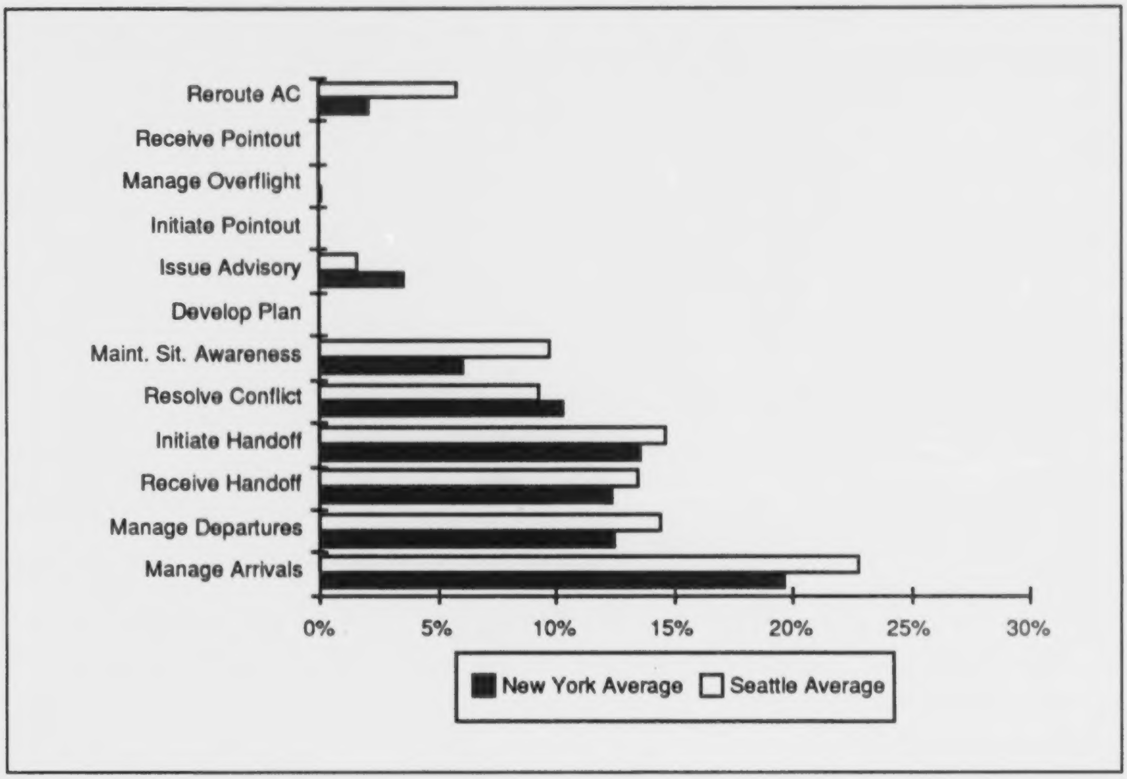
The controller task frequency percentages were submitted to statistical tests to verify that there were no significant differences between the Centers for each task. No significant differences emerged for any task category. Thus, there is a stable pattern of interaction between R-side controllers and pilots found in the communication analysis, and a similar stable pattern in the tasks about which the R-side controllers communicate with pilots.

Table 5.10. Ground-Air Controller Task Frequency Percentages for Each Session

	NY1	NY2	NY3	NY4	SEA1	SEA2	SEA4
Develop Plan	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Issue Advisory	3.5	5.5	3.6	1.9	0.0	1.7	3.0
Initiate Handoff	13.4	11.9	16.0	12.7	19.7	13.3	10.5
Initiate Pointout	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manage Arrivals	17.3	18.3	19.5	22.9	9.4	27.0	31.6
Manage Departures	13.0	8.5	19.5	8.3	23.1	4.7	15.0
Manage Overflights	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Maintain Situation Awareness	6.7	6.4	5.9	5.1	4.3	20.2	4.5
Noncodable	16.5	26.4	10.7	28.0	4.3	11.6	11.3
Resolve Conflict	10.2	12.8	10.1	7.6	8.5	7.7	11.3
Receive Handoff	14.1	9.8	13.0	12.1	20.5	9.9	9.8
Receive Pointout	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reroute Aircraft	5.3	0.0	1.8	1.3	10.3	3.9	3.0

Ground-Air Tasks (Continued)

Figure 5.7. Ground-Air Task Categories by Center



R-side controllers did not develop plans with pilots. They did engage in a small amount of communication with pilots to maintain their situation awareness; for instance, to verify altitudes and headings. This ground-air pattern of tasks was most similar to ground-line communication with its preponderance of operational as opposed to cognitive tasks. Ground-air communication was least similar to team communication, with the latter's emphasis on planning and maintenance of situation awareness.

GROUND-LINE COMMUNICATIONS

Ground-line communications were produced primarily by the radar associate controllers. However, in six of the seven sessions, the R-side controllers did generate a small percentage of the ground-line communications.

GROUND-LINE COMMUNICATIONS (Continued)

The following differences emerged between the Centers for the communication category frequency distributions (see Figure 5.8 for a graph of the Center means for each of the communication categories). New York Center had higher frequencies for "command/request" (32 percent), "courtesy comment" (12 percent), "acknowledgment" (6 percent), "answer" (4 percent), "inquiry—intent" (2 percent), and "clarify response" (1 percent). Seattle Center had higher levels of "observation" (28 percent), "agreement" (7 percent), "inquiry—situation" (6 percent), "statement of intent" (5 percent), "disagreement" (1 percent), and "suggestion" (0.4 percent).

Figure 5.8. Ground-Line Communication Categories by Center

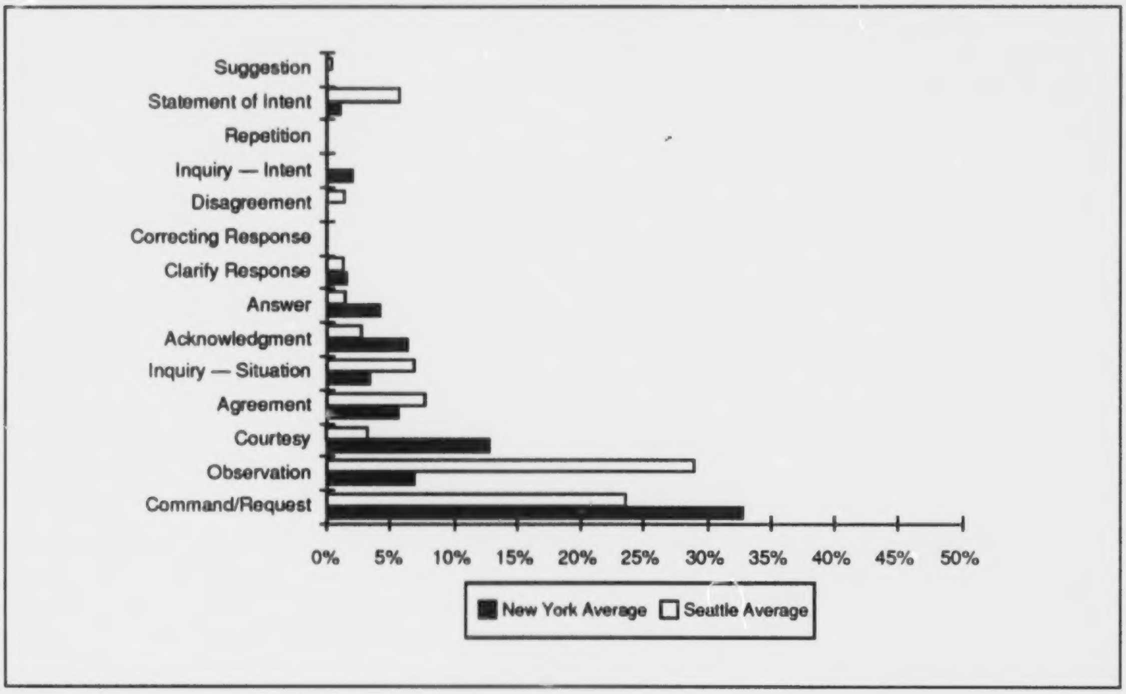


Table 5.11 lists the frequency percentages for each session. The relatively high percentages of noncodable communications for the New York sessions reflect the problem of not being able to hear the incoming part of the ground-line interaction in New York.

GROUND-LINE COMMUNICATIONS (Continued)

Table 5.11. Ground-Line Communication Category Frequency Percentages for Each Session

	NY1	NY2	NY3	NY4	SEA1	SEA2	SEA4
Acknowledgment	4.1	4.3	4.4	12.1	0.0	5.0	3.0
Agreement	6.2	4.3	5.9	6.1	15.8	7.5	0.0
Answer	3.1	1.4	2.9	9.1	0.0	1.3	3.0
Command/Request	36.1	36.2	33.8	24.2	36.8	21.3	12.1
Courtesy Comment	12.4	15.9	22.1	0.0	5.3	1.3	3.0
Clarify Response	1.0	1.4	1.5	3.0	0.0	3.8	0.0
Correcting Response	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disagreement	0.0	0.0	0.0	0.0	0.0	1.3	3.0
Inquiry—Intent	2.1	1.4	1.5	3.0	0.0	0.0	0.0
Inquiry—Situation	3.1	4.3	5.9	0.0	0.0	11.3	9.1
Noncodable	25.8	24.6	14.7	27.3	10.5	13.8	3.0
Non-Task-Related	0.0	0.0	0.0	3.0	0.0	0.0	24.2
Observation	5.2	5.8	7.4	9.1	31.6	27.5	27.3
Repetition	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Statement of Intent	1.0	0.0	0.0	3.0	0.0	5.0	12.1
Suggestion	0.0	0.0	0.0	0.0	0.0	1.3	0.0

The ground-line communication category frequencies were submitted to ANOVA's to investigate the differences in communication categories between the two Centers. The ANOVA's revealed a main effect between Centers for "observation" ($F = 196.511$, $df = 1, 5$, $p < .05$), "inquiry—intent" ($F = 21.164$, $df = 1, 5$, $p < .05$) and "noncodable" comments ($F = 10.566$, $df = 1, 5$, $p < .05$). In sum, "inquiry—intent" and "noncodable" comments were significantly more common in New York, while "observation" was significantly more common in Seattle.

To further explore the factors that might be influencing the frequency of communication categories, correlations were calculated between the ground-line communication category frequency percentages and three different measures that appeared to have some relationship to the patterns of communication for the ground-line data. These measures were: 1) FPL experience, 2) controller assessments of traffic volume, and 3) controller assessments of traffic complexity.

For FPL experience, significant correlations were found with "disagreement" ($r = -.85$), "inquiry—intent" ($r = .83$), "inquiry—situation" ($r = -.83$), and "noncodable" comments ($r = .82$). "Inquiry—intent" and "noncodable" comments increase with FPL experience while "disagreement" and "inquiry—situation" decrease with FPL experience.

GROUND-LINE COMMUNICATIONS (Continued)

The traffic volume ratings were significantly correlated with "noncodable" comments (r = .88). Thus, with higher traffic volumes, there were more comments that could not be coded.

Again, the correlations between FPL experience and "noncodable" comments and traffic volume ratings and "noncodable" comments may simply reflect the problem of not being able to hear the incoming part of the ground-line interaction in New York (where both FPL experience and traffic volume were generally higher).

The traffic complexity ratings showed no significant correlations with any of the ground-line communication categories.

Ground-Line Tasks

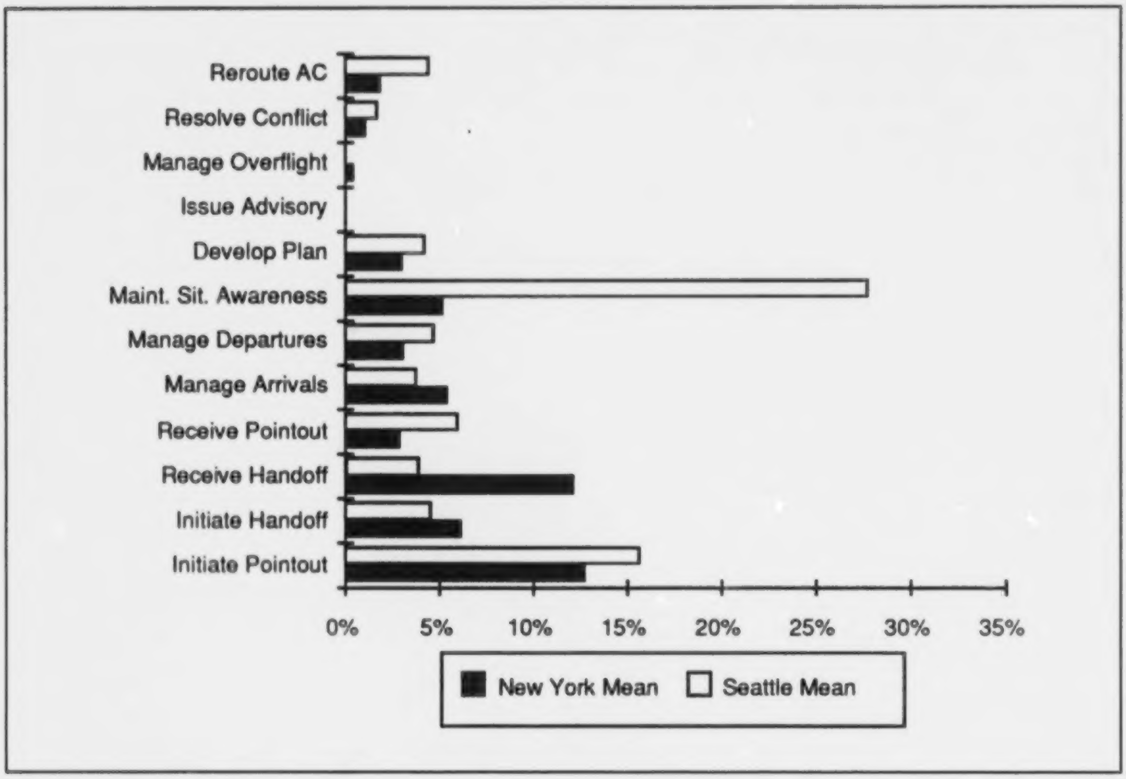
Inspection of the task data reveals that New York Center had higher levels of ground-line communication for the following task categories: receive handoff (12 percent), initiate handoff (6 percent), and manage arrivals (5 percent). Seattle Center had higher levels of ground-line communication for: maintain situation awareness (27 percent), initiate pointout (15 percent), receive pointout (5 percent), manage departures (4 percent), reroute aircraft (4 percent), develop plan (4 percent), and resolve conflict (1 percent). These percentages are illustrated graphically in Figure 5.9.

The majority of the Seattle Center sessions were of lower traffic volume and complexity than the New York sessions; this situation may explain some of the differences in task frequencies. Also, the large percentage of noncodable ground-line communications from the New York sessions makes these data difficult to interpret.

The frequencies of tasks for ground-line communication were different from the patterns found in team communication and ground-air communication. The controller in the ground-line situation is most similar to the R-side controller in the ground-air situation, with a strong emphasis on accomplishing operational tasks. However, a small percentage of the ground-line communications in both New York and Seattle related to sector planning, and a large percentage of the ground-line communications in Seattle related to maintaining situation awareness.

Ground-Line Tasks (Continued)

Figure 5.9. Ground-Line Task Categories by Center



Ground-Line Tasks (Continued)

Table 5.12. Frequency Percentages of Ground-Line Controller Tasks by Center

Task Category	New York Center	Seattle Center
Develop Plan	2.9	4.1
Issue Advisory	0.0	0.0
Initiate Handoff	6.0	4.4
Initiate Pointout	12.5	15.4
Manage Arrivals	5.3	3.6
Manage Departures	3.0	4.5
Manage Overflights	0.4	0.0
Maintain Situation Awareness	5.1	27.3
Noncodable	46.8	25.1
Resolve Conflict	1.0	1.7
Receive Handoff	12.0	3.8
Receive Pointout	2.9	5.8
Reroute Aircraft	1.8	4.3

VI. SUMMARY

SUMMARY

TEAM COMMUNICATION

The team communication roles of the radar controller and the radar associate controller are shaped by their different tasks and responsibilities as team members. The live traffic results demonstrated that the major functions of communication within the controller team are to update situational awareness and develop plans about the traffic in the sector. These two cognitive tasks of "maintaining situation awareness" and "developing and revising the sector control plan" accounted for more than 80 percent of the total team communication.

The simulated traffic analyses showed a number of differences between radar controller (R-side) and radar associate controller (D-side) use of speech turns. These analyses help to clarify the different roles that the two controllers have in developing plans and maintaining situational awareness. Although the R-side and D-side controllers both used "observations" as their most frequent form of team communication, there were important differences. After observations, the most frequent R-side communication category was "situational inquiry." The R-side used significantly more situational inquiries than the D-side, indicating the R-side's need to update his or her situational awareness. The R-side also used more "acknowledgments" and "courtesy comments" than the D-side. It is possible that the R-side used these two forms of communication to help further team coordination. Finally, the R-side made more "statements of intent" compared with the D-side. This finding reflects the R-side's greater involvement with the sector plan, and this larger number of R-side statements may also be a result of the D-side's greater number of intentional inquiries. Based on the R-side usage of specific communication categories, it can be inferred that the R-side has a dominant interest in the sector plan and in team coordination. The R-side also has a need for information to update situational awareness.

The D-side provides situational awareness information to the R-side through a greater use of the "observation" and "answer supplying information" categories. These are the two most frequently used D-side communication categories suggesting that the main team communication function of the D-side is to update the team's situational awareness. In addition, the D-side uses more "suggestions" and more "inquiries about intent" as compared to the R-side. The D-side utilizes these two communication categories to keep informed of the R-side's sector plan and to offer possible revisions or modifications to that plan.

The simulated traffic results described above are supported by the live traffic analyses. In the live traffic study, the radar associate controllers also made more "observations," more "answers supplying information," and more "inquiries about intent" than did the radar controllers.

The live traffic team communication analyses indicated that the two cognitive tasks, "maintain situation awareness" and "develop and revise sector control plan," are the essential focus of team interaction. Differences emerged in the way in which the teams employed communication categories to support these two tasks. "Observation" and "inquiry about situation" were used more often than other communication categories to maintain situation awareness. "Observation" and "statement of intent" were the most frequent communication categories for developing and revising the sector control plan. Also, the live traffic results indicated that less experienced controllers discussed planning more than their more experienced counterparts.

TEAM COMMUNICATION (Continued)

Data from both simulated and live traffic analyses indicate that the D-side puts much team communication effort into updating the team's situational awareness. In addition, comments from the team debriefings suggest that the D-side can have a better understanding of traffic in adjoining sectors. For example, participants in the simulated traffic study stated that when the D-side is looking at a limited datablock outside the sector, the D-side can warn the R-side of potential traffic. It was also mentioned that a good D-side is looking out on the fringes while the R-side takes care of what is in the sector. Another participant indicated that the D-side can often look out further than the R-side and that the D-side knows before the R-side when things are going to get busy. It is evident that the D-side has the opportunity to develop a longer-range perspective, and the D-side's principal function in team communication is to update the R-side.

Both the live traffic data and the simulated traffic data indicate that the R-side controller has a need to acquire situational information and to communicate about the sector plan. The debriefing comments emphasized the R-side's need to communicate about the sector plan. For example, one of the participants said, "On the R-side, I will say 'I am watching these two,' or 'I am going to turn this guy behind him,' just to keep the D-side informed."

In general, these results indicate that the R-side controller has the key team communication functions of keeping the team informed about the sector control plan and requesting information to update situational awareness. The D-side controller's key team communication function is to supply the R-side with the critical information to update situational awareness. The D-side uses a mix of observations and answers supplying information to keep the R-side informed of situations that will affect the sector. As suggested by the correlation between team performance and D-side controller experience, the more experienced D-side controllers were better able to update the team's situational awareness.

Team communication frequencies were not significantly affected by workload, indicating that an increase from moderate to heavy workload did not change the overall team communication. A significant interaction between performance level and workload illustrated how top performers differ under the condition of heavy workload. Top performers make relatively more statements of agreement under heavy workload while the bottom performers make fewer such statements under heavy workload. One of the participant debriefing comments provides a possible explanation for this interaction. The participant emphasized that without a good D-side, the R-side has to work much harder. The fact that the top-performing teams were able to make more statements of agreement under heavy workload is a possible indicator that the R-side was not overloaded and was able to maintain team communication.

TEAM COMMUNICATION (Continued)

The top performance sessions have significantly fewer "commands," "situational inquiries," "answers supplying information," "disagreements," and "response uncertainties." There is an apparent trend where the better teams have less of certain types of communication. This trend leads to the question, "How do the top teams perform well with less team communication?" One answer comes from the participant debriefings where a number of comments indicated that team members use a lot of nonverbal communication. For example, if the R-side has initiated a handoff, the D-side may tilt the strip in the bay as a reminder that the aircraft needs to be shipped. The D-side may put a marking on a strip to indicate that two planes are coming together. As workload increases, it is evident that these forms of nonverbal communication become essential. As one of the participants commented, "When things are busy, we do not talk much to each other; we put it on the strips."

Some of the correlational data provide further insights into the top performing teams. First, the correlations between the SME overall team operation ratings and the teams' own subjective ratings showed that the teams that rated themselves higher on situational awareness, adaptability/flexibility, decisionmaking, and overall teamwork had higher SME overall team operation ratings. Second, the correlations between performance measures and situational characteristics indicated that top-performing teams tend to rate the following statements as being less descriptive of the air traffic control situation:

- Tasks can be reallocated among team members during performance.
- The completion of tasks by one team member depends on the completion of tasks by the other team member.
- Tasks require input of both team members.
- The team members are required to exercise extensive decisionmaking and problem-solving skills.

Taken together, these correlations suggest that the top-performing teams see themselves as having better situational awareness, adaptability, decisionmaking, and teamwork; and that teamwork is defined in terms of fulfilling independent responsibilities where tasks tend not to be reallocated among the team members and most tasks are completed relatively independently of the other team member. The critical exceptions to this pattern of independent task performance are the two cognitive tasks of developing and revising the sector control plan (DP) and maintaining situational awareness (MS). These two tasks require the bulk of team communication so that they can be executed effectively. The R-side needs to keep the D-side apprised of plan revisions, and the D-side needs to keep the R-side updated on events that will affect situational awareness.

Although these communication analyses concentrated on the verbal component of team communication, it is evident that nonverbal behavior plays an important role in team communication. This nonverbal communication consists of gestures such as pointing to a strip or the PVD as well as writing on strips and tilting strips in the bay.

GROUND-AIR COMMUNICATION

The results of the simulated traffic analyses demonstrated that more than 65 percent of ground-air speech turns were "commands" issued to pilots. The next most frequent ground-air categories were "acknowledgments" and "reports." Nonroutine communication speech turns (responses correcting presented information and response uncertainty) made up less than 3 percent of all ground-air communication. The results of the live traffic analyses identified the three major ground-air communication categories as "command/request," "acknowledgment," and "statement of intent." The common thread in these types of speech acts is that they are active and often aimed at minimizing the number of transactions between pilots and the R-side controller. The large number of commands/requests reflects the function of the R-side controller to actively regulate traffic flow. Commands and requests initiate transactions and are characteristic of the active role taken by the R-side controller to implement control. Acknowledgments serve as the "punctuation marks" on these transactions, indicating that the readbacks of pilots have been heard and are correct.

Workload made a significant difference in the frequency of the two most common ground-air communication categories, "command" and "acknowledgment." In both cases, more frequent use of those speech turn types occurred under the condition of heavier workload. In addition, there were significantly more noncodable turns for the heavy workload problems as compared to the moderate workload problems. These findings add more details to the general analysis finding that the R-side controller used more speech turns when working the heavy workload problems. As common sense would predict, the controllers issued more commands and acknowledgments to pilots when working heavy workload problems.

There were significant differences between the top and bottom performance sessions for a number of the ground-air speech categories. Controllers in the top sessions used significantly more "commands," more "reports," and more "answers supplying information" than did the controllers in the bottom-rated sessions. However, controllers in the top-rated sessions made significantly fewer responses expressing uncertainty than did the controllers in the bottom-rated sessions. A significant interaction showed that top performers issued relatively more commands under conditions of heavy workload. It was the top-performing controllers who accounted for the greater number of commands in the presence of heavy workload, while the controllers in the bottom sessions showed little difference between the two workload conditions in their use of commands. This last finding may be related to the team communication finding that the top teams were better able to cope with the heavy workload. In the case of ground-air communication, the top teams were able to keep up with the increased traffic and issued the required greater number of commands. There is also anecdotal evidence that top performers break up their commands into smaller units to ensure accuracy under heavy workload conditions. This hypothesis could be investigated further by a reanalysis of the ground-air communication transcripts.

GROUND-AIR COMMUNICATION (Continued)

The live traffic analyses identified the predominant ground-air tasks as those directly related to controlling aircraft (managing arrivals and departures), initiating and receiving handoffs, resolving conflicts, rerouting aircraft, and issuing advisories. These tasks are the core of implementing the plan for controlling sector traffic. A small amount of ground-air communication involves maintaining the R-side controller's situation awareness through inquiries to pilots about situational factors such as aircraft speed or altitude. Development of plans does not occur in ground-air communication although the sector plan can greatly affect ground-air communication. In sum, the two major cognitive tasks are much less frequently involved in the ground-air interactions.

GROUND-LINE COMMUNICATION

The results of the simulated traffic ground-line communication analyses were based on D-side controller speech turns. The D-side communication with other sectors was made up primarily of "acknowledgments," which accounted for 55 percent of all ground-line speech turns, with "command" as the next most frequently used category (15 percent).

The simulated traffic results showed a significant effect of workload for "command" and "answer supplying information." There was a greater use of both these communication categories when controllers were experiencing heavy workload. In contrast, "pointouts" were given significantly less frequently under conditions of heavy workload.

The top-performing controllers used significantly fewer "pointouts," "acknowledgments," and "response uncertainties" than did the controllers in the bottom-rated sessions. An interaction showed that controllers in the top-rated sessions made more "commands" under heavy workload as compared to moderate workload, while the controllers in the bottom-rated sessions showed little difference in commands between the two workload conditions. A second interaction helps to explain a strategy used by top-rated controllers to deal with heavy workload. The top-performing controllers showed little increase in verbal handoffs under heavy workload. In contrast, the controllers in the bottom-rated sessions showed a significant increase in verbal handoffs when working the heavy workload problems. This difference provides an example of how top-rated D-side controllers better manage their sector communication when handling the heavier workloads.

The live traffic analyses showed that the ground-line communication pattern reflects a "hybrid" of the team and ground-air communication patterns. Ground-line communication most resembles ground-air communication in the way the controller uses "commands/requests," "statements of intent," and "repetition." This finding indicates that one aspect of ground-line communication is taking the lead and implementing control actions through commanding, making requests, and explicitly stating intent. In some cases, commands are used in ground-line communication to minimize workload in the same way that commands are used in ground-air communication. Commands curb dialogue in situations where a lack of directness and clarity could increase the number of transactions between sectors. Commands can also eliminate potential dangerous ambiguity regarding the plans of one sector that directly influence another.

GROUND-LINE COMMUNICATION (Continued)

The levels of occurrence of "agreement," "answers," "clarification," "observation," and "suggestion" in ground-line communication parallel some patterns found in team communication. These ground-line patterns indicate that a form of cooperative dialogue (teamwork) takes place between sectors. This finding suggests that another ground-line function is to share plans and knowledge in a way that is similar to the sharing that occurs within the sector team. Although the operational tasks predominate in ground-line communication, the cognitive tasks of maintaining situation awareness and developing the sector plan are represented, reflecting the teamwork that takes place in coordination with other sectors.

VII. TRAINING IMPLICATIONS

TRAINING IMPLICATIONS

Provided that the findings of this project are cross-validated, the following implications emerge from this research:

- Advanced communication training for en route air traffic controllers should be embedded in the relevant training on those controller tasks that are primarily cognitive (e.g., planning and maintaining situation awareness) and those controller tasks that are primarily operational (e.g., managing arrivals, departures, handoffs, etc.).

- In addition to an increased emphasis on accurate and efficient communication with pilots (including correct phraseology), a new emphasis should be placed on the functions of different types of communication within controller teams and between controller teams and other sectors and facilities.

    - By linking communication skill training to specific task training, controllers will have a better understanding of the purposes of various kinds of communications, and they can be taught how to accomplish those purposes in the most effective and efficient manner.

    - For example, if the purpose of a communication were to help the team maintain situation awareness, training could focus on the most effective and efficient ways of making observations, asking questions, and providing answers. On the other hand, if the purpose of a communication were to better manage departures when the workload in the sector is increasing, training could focus on how to make the most accurate and efficient request to an adjoining sector controller.

- The goal of en route controller communication training should be to provide controllers with an extensive repertoire of communication skills and techniques that the controllers can use on a selective basis to accomplish specific tasks.

    - Within the context of task training, specific communication skills and techniques should be practiced to a high level of proficiency. Just as a clearance should always contain correct phraseology, a radar associate controller's inquiry or answer to a radar controller should always contain certain basic elements in order to be an effective contribution to sector planning or maintaining situation awareness.

    - In the same way that vectoring, altitude adjustment, or speed adjustment are specific control actions that can be learned and used to accomplish specific purposes, different types of communication can be learned and used with equal precision to accomplish specific purposes.

- In particular, developmental controllers should be trained in the skills, and choices of communication strategies, that were demonstrated by the controllers in the top-rated teams in this study:

  - When learning team communication, emphasis should be placed on learning effective and efficient techniques for:

    - Making observations
    - Asking questions
    - Answering questions
    - Stating intentions

  - When learning ground-air communication, in addition to emphasizing correct phraseology and listening for correct readbacks, a new emphasis should be placed on learning effective and efficient techniques for:

    - Giving commands
    - Making acknowledgments
    - Giving reports
    - Asking questions
    - Increasing commands during heavy workload

  - When learning ground-line communication, emphasis should be placed on learning effective and efficient techniques for:

    - Making acknowledgments
    - Giving commands (making requests)
    - Asking questions
    - Giving reports
    - Minimizing verbal handoffs and pointouts
    - Increasing commands during heavy workload

  - When practicing all types of controller communication, emphasis should be placed on:

    - Timing
    - Word choice
    - Completeness

VIII. REFERENCES

REFERENCES

Foushee, H. C., Luaber, J. K., Baetge, M. M., & Acomb, D. B. (1986). Crew Factors in Flight Operations: III. The Operational Significance of Exposure to Short-Haul Air Transport Operations. Moffett Field, CA: NASA Ames Research Center, NASA Technical Memorandum 88322.

Grayson, R. L., & Billings, C. E. (1981). Information transfer between air traffic control and aircraft: Communication problems in flight operations. In C. E. Billings and E. S. Cheaney (Eds.), Information Transfer Problems in the Aviation Systems. NASA TP-1875.

Helmreich, R. L., Chidester, T. R., Foushee, H. C., Gregorich, S., & Wilhelm, J. A. (1989). How Effective Is Cockpit Resource Management Training? Issues in Evaluating the Impact of Programs To Enhance Crew Coordination. NASA/UT Technical Report 89-2.

Human Technology, Inc. (1990). Cognitive Task Analysis of Prioritization in Air Traffic Control. Report to the Federal Aviation Administration. McLean, VA: Human Technology, Inc.

Human Technology, Inc. (1991). Cognitive Task Analysis of En Route Air Traffic Control: Model Extension and Validation. Report to the Federal Aviation Administration. McLean, VA: Human Technology, Inc.

Kanki, B. G., Lozito, S., & Foushee, H. C. (1989). Communication indices of crew coordination. Aviation, Space, and Environmental Medicine, 60:1, 56-60.

Loftus, G. R., Dark, V. J., & Williams, D. (1979). Short-term memory factors in ground controller/pilot communication. Human Factors, 21, 169-181.

Morrow, D. G., Lee, A., & Rodvold, M. (1990). Analysis of routine pilot-controller communication. In Managing the Modern Cockpit: Third Human Error Avoidance Techniques Conference Proceedings. Warrendale, PA: Society of Automotive Engineers.

Suchman, L. (1985). Plans and Situated Actions: The Problem of Human-Machine Communication. Palo Alto, CA: Xerox Corporation Palo Alto Research Centers.

ANALYSIS OF CONTROLLER COMMUNICATION IN EN ROUTE AIR TRAFFIC CONTROL

Volume II. Appendixes

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APPENDIXES

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APPENDIX A: SIMULATED TRAFFIC: TEAM COMMUNICATION ANALYSES

A-1.0 Team Communication Coding Scheme

Courtesy Comment:	A speech turn aimed at building a positive relationship by showing courtesy (e.g., thank you) or appreciation (e.g., nice job).
Command:	A specific assignment of responsibility in the form of a declarative statement or a request for action.
Inquiry – Situational:	A request for factual information relating to past or present tasks; not a request for action.
Inquiry – Intent:	A request for information about another's intended action. Included inquiries about present and future actions, but not to previous actions.
Observation:	A remark aimed a recognizing and/or noting a fact or occurrence relating to the task.
Suggestion:	Suggesting a course of action directly as a recommendation.
Statement of Intent:	An announcement of intended action by the speaker. Includes statements referring to present and future actions, but not to previous actions.
Acknowledgment:	Verbally makes known that a prior speech turn was heard; does not supply additional information; does not evaluate or correct a prior speech turn; does not express courtesy.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment, agreement, or disagreement.
Agreement:	A response indicating concurrence with a previous speech turn; a positive evaluation of a prior speech turn.
Disagreement:	A response not in concurrence with a previous speech turn; a negative evaluation of a prior speech turn.
Response Correcting Presented Information:	A response that questions the accuracy of or corrects a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard and/or not understood.
Non-Task-Related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

A-1.1 User Instructions

Appendix A includes the following sections with the results of the Team Communication data analyses:

A-2.0 Summary of Team Communication Turn Frequencies by Team Type

These turn frequencies represent the average number of occurrences for each communication category grouped by the eight team types. The data has been further subdivided by workload (MODERATE, HEAVY, and COMBINED) and side (R-SIDE, D-SIDE, and TOTAL).

A-3.0 ANOVA's: Team Communication for Team Type

These ANOVA Tables are reported in the same order as the communication types listed on the previous page (starting with Courtesy Comment and ending with Noncodable). If there are significant main effects, the means and/or Duncan New Multiple Range results are shown. And if there are significant interactions, they are represented graphically.

A-4.0 ANOVA's: Team Communication – SME Overall Team Operation

These ANOVA Tables are reported in the same order as the communication types listed, and the effects are reported in the same way as with the Team Type ANOVA's in A-3.0.

A-5.0 ANOVA's: Team Nonroutine Communication Performance

These ANOVA Tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in A-3.0.

A-6.0 ANOVA's: Team Communication Inaccuracy Performance

These ANOVA Tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in A-3.0.

A-7.0 Additional ANOVA's – Nonroutine Communications

This section has the ANOVA's for combined nonroutine (COMBINED-NONR) communications, team nonroutine communications (TEAM-NONR), ground-line nonroutine communications (LINE-NONR), and combined inaccuracies (TOTAL INACC).

A-8.0 Team Communication Correlations – Objective & Subjective

The correlations with objective (communication categories) data are reported first followed by those with the subjective data. The legends at the bottom of each page provide an explanation of the abbreviated variable names.

A-1.2 Team Communication Coding Rules and Procedures – Final Version

Procedures

Coders will code directly on a copy of the original transcript using a pencil.

When starting to code a transcript, coders will print the date, their initials, type of communication being coded (TEAM, G-A, or G-L), Problem Number, and Session Number in the upper left-hand corner of the transcript cover sheet.

If it is clear that the transcript has the wrong speaker label for a turn that is being coded, coders will cross out that speaker label (R-Side or D-Side) and write in the proper identification.

Begin coding a transcript with the first task-related turn, and do not code any of the previous communication. If a transcript has one task-related turn at the beginning followed by a lot of non-task comments, code the task-related turn, but do not code the non-task comments.

Coders will place the code numbers in the left-hand margin in front of the line number for the starting line of the appropriate turn.

In the case of multiple codes, the coders may place up to three codes by the starting line of the turn and should use commas to separate the code numbers.

If a group of turns is sufficiently ambiguous to be properly coded, then the coder will bracket those line numbers on the left and write "CHECK TAPE." The coder will then check the audio or video tape and code. If still ambiguous, the coder will add "NO CODE" below "CHECK TAPE."

When coding, focus on the surface structure of the utterance, and avoid trying to code underlying inferences.

General Team Communication Coding rules

If there is ambiguity in a turn, consider the turn in the context of the transaction and use the overall purpose of the transaction to help determine the code. For example, if several turns of a transaction are 14's, then it is likely that the rest of the turns are 14's.

In general, simplify the coding of turns by identifying the primary purpose. You may double or triple code when there are two or more different purposes within a turn.

Do not code 14's or 15's (non-task-related comments or noncodables) in a turn that contains task-related comments, replies, or inquiries, and do not code 14's or 15's that may be another communication type.

Do not code any comments or inquiries that are directed to the SME or some other non-team members.

Team Inquiries and Interruptions

When coding, rely on the "?" in the transcriptions and assume they imply inquiries.

In the case of task-related responses to non-task-related inquiries, both turns should be coded as task-related (3 - 9).

If a task-related inquiry is made but not answered due to an interruption, then code the inquiry as a 3 or 4.

If a task-related inquiry is made but not answered, and there are no interruptions, then the inquiry may be coded as a 15 (the controller may be speaking to self).

Code interruptions that are acknowledgments as an 8, but do not code interruptions that are 14's or 15's (non-task-related comments or noncodable comments). In the case of brief interruptions, code the interrupted communications as a single turn.

Team Communication Code Refinements

Code 1: Include such comments as "Sorry about that."

Code 4: Include inquiries about plans as well as actions.

Code 6: Limit the use of this code to obvious suggestions.

Code 7: Include statements about plans as well as actions.

Code 8: Acknowledgment is the most general form of a response, but it should only be used in cases where the prior turn was directed to the person acknowledging. Also use Code 8 when a command has been acknowledged. Forms of acknowledgment include: "OKAY," "GO IT," "I HEAR YOU," "ROGER," and "UHUH."

Code 9: Use this code only where the comment is in response to a direct question. This includes cases where a "YES" or "NO" is used in response to a "YES-or-NO" question.

Code 10: Use this code when there is evidence of a positive evaluation. The following utterances all provide evidence of a positive evaluation: "YES," "YEAH," "YEP," and "THAT'S RIGHT."

Code 11: Use this when there is clear evidence that a negative evaluation was made as is indicated by the use of "NO" or "NOPE."

Code 12: Limit this code to responses that correct the other team member, and do not use it for self-correcting comments.

Code 13: Limit this code to cases where it is clear that the previous response was not heard or understood. Use this code for utterances that are followed by repeated information, corrections, or clarification. Examples of 13's include "HUH" and "DO WHAT?".

Code 14: In addition to non-task-related comments, use this for off-the-cuff remarks or jokes and comments or inquiries about the sector or the equipment.

Code 15: Use this code when the turn is mostly inaudible or does not make sense because it is incomplete, and the turn does not appear to significantly contribute to team communication. If you think is may be significant, mark it as "CHECK TAPE." Then check tape before deciding if it is a 15. In addition, use this to code in the following situations:

When team member is speaking to himself
When a sound rather than a word is uttered
When the team member mumbles or makes a slip

A-1.3 Measurement of Performance Instruments

Session Evaluation Form - Controller Communication Analysis

Session #: _______________ Date #: _________ Evaluator: ______________________________

Instructions:
Following each session, please rate the team with an emphasis on communication and performance. For each element, circle the appropriate rating, trying to keep the criteria constant across DYSIM problems and different teams. Use the scale below where 1 = poor, 4 = satisfactory, and 7 = very efficient. Use as much of the scale as possible so that we can determine differences between teams.

	Poor		Satisfactory				Very Efficient
Overall Team Operation							
Managing separation	1	2	3	4	5	6	7
Managing traffic flow	1	2	3	4	5	6	7
Providing service to aircraft	1	2	3	4	5	6	7
Overall efficiency	1	2	3	4	5	6	7
Overall R-Side Operation	1	2	3	4	5	6	7
Overall D-Side Operation	1	2	3	4	5	6	7
Team Communication							
Verbal communication	1	2	3	4	5	6	7
Nonverbal communication	1	2	3	4	5	6	7
Written communication	1	2	3	4	5	6	7
Communicating with Pilots							
Timeliness	1	2	3	4	5	6	7
Efficiency	1	2	3	4	5	6	7
Phraseology	1	2	3	4	5	6	7
Communicating with Other Sectors							
Timeliness	1	2	3	4	5	6	7
Efficiency	1	2	3	4	5	6	7
Phraseology	1	2	3	4	5	6	7

GROUND-AIR INACCURACIES TALLY SHEET

Team Name Codes: ______________________________

Analyst: ______________________________ Date: ______________

Problem Being Analyzed: ______________________ Session #: __________

Type of Ground-Air Inaccuracy	R-Side
1. Center/Sector Identification	
2. Acknowledgment	
3. Command	
4. Report	
5. Other Controller Inaccuracy	
6. Missed Incorrect Callsign	
7. Missed Incorrect Readback	
8. Missed Lack of/Incorrect Acknowledgment	
9. Missed Other Pilot Inaccuracy	

Notes:

GROUND-LINE INACCURACIES TALLY SHEET

Team Name Codes: ______________________________

Analyst: ______________________________ Date: ______________

Problem Being Analyzed: ______________________________ Session #: __________

Type of Ground-Line Inaccuracy	R-Side	D-Side
1. Center/Sector Identification		
2. Addressee Callsign		
3. Handoff		
4. Pointout		
5. Command/Other Action Request		
6. Other Controller Inaccuracy		
7. Missed Incorrect Callsign		
8. Missed Incorrect Readback		
9. Missed Incorrect Acknowledgment		
10. Other Missed Inaccuracy		

Notes:

TEAM COMMUNICATION

Code: ______________________ Position Worked: R-Side D-Side

Date: ______________________ Session #: ______________________

Introduction

This survey is designed to determine the extent to which several teamwork behaviors and conditions contribute to successful teamwork. The survey is divided into three sections. The first section requests that you rate the behavioral requirements that are characteristic of the other controller on your team. The second section requests that you rate several requirements of the air traffic control situation. The third section asks about the overall workload and the effectiveness of the teamwork. Information gathered with this survey will provide valuable guidance for the development of training interventions that can improve training effectiveness.

Teamwork Behaviors

In order to complete this section, please think about the behaviors you observed in the other controller on your team. Read each statement below and enter a number in order to indicate how characteristic the described behavior was of the other controller on your team. Using the following scale, please write the number corresponding to your rating in the space provided by each item. Thank you for your help.

0	1	2	3	4	5	6	7
Don't Know		Not At All Characteristic			Moderately Characteristic	Highly Characteristic	

1. SITUATIONAL AWARENESS

____ 1.1 Devised long- and short-term plans.
____ 1.2 Provided information in advance.
____ 1.3 Identified problems/potential problems.
____ 1.4 Demonstrated ongoing awareness of situation status.

2. ASSERTIVENESS

____ 2.1 Asked questions when uncertain.
____ 2.2 Called my attention to important situations.
____ 2.3 Made suggestions.

Continued . . .

TEAM COMMUNICATION (Continued)

0	1	2	3	4	5	6	7
Don't Know		Not At All Characteristic			Moderately Characteristic		Highly Characteristic

3. ADAPTABILITY/FLEXIBILITY

____ 3.1 Made rapid adjustments to meet situational demands.
____ 3.2 Fitted into game plan for handling situations.
____ 3.3 Was open to accepting suggestions.

4. TEAMWORK

____ 4.1 Demonstrated awareness of what I needed to accomplish my tasks.
____ 4.2 Knew how to assist when I was busy.
____ 4.3 Cooperated at all stages of task performance.
____ 4.4 Showed confidence in my information and/or decisions.
____ 4.5 Sought advice at appropriate times.

5. COMMUNICATION

____ 5.1 Acknowledged communication (e.g., OK, check, roger).
____ 5.2 Initiated providing information at the time it was required.
____ 5.3 Provided information when asked.
____ 5.4 Timed communication so it did not interfere with my work.
____ 5.5 Conveyed information concisely.
____ 5.6 Verbalized game plan.
____ 5.7 Verbalized changes to game plan.
____ 5.8 Used nonverbal communication appropriately.

6. DECISION MAKING

____ 6.1 Gathered data before making a decision.
____ 6.2 Identified alternatives.
____ 6.3 Anticipated consequences of decisions.

TEAM COMMUNICATION (Continued)

7. SITUATIONAL CHARACTERISTICS

In order to complete this section, please read each of the following statements and indicate the extent to which the statement describes the air traffic control situation in this problem. Please write the number corresponding to your rating in the space provided by each item. Thank you for your help.

0	1	2	3	4	5	6	7
Don't Know		Not At All Descriptive		Moderately Descriptive		Extremely Descriptive	

____ 7.1 Discussion between team members is necessary for decisions to be reached.
____ 7.2 Most of the situations that arise are initially unpredictable to the team.
____ 7.3 Specific tasks to be performed by the team are difficult to determine in advance.
____ 7.4 Tasks can be reallocated among team members during performance.
____ 7.5 The completion of tasks by one team member depends on the completion of tasks by the other team member.
____ 7.6 Tasks require the input of both team members.
____ 7.7 Team members are required to exercise extensive decision making and problem-solving skills.

8. OVERALL WORKLOAD AND TEAM EFFECTIVENESS

8.1 How busy was the sector?

0	1	2	3	4	5	6	7
Not At All Busy							Very Busy

8.2 Overall, what percentage of the workload was handled by the other team member? ___%

8.3 Given the responsibilities of the two positions in the sector, would you consider this workload distribution to be:

(Circle one)
5 - Fair
4 - Somewhat Fair
3 - Neither Fair Nor Unfair
2 - Somewhat Unfair
1 - Unfair

Continued . . .

TEAM COMMUNICATION (Continued)

8. OVERALL WORKLOAD AND TEAM EFFECTIVENESS (Continued)

8.4 Think about the amount of work you had to do to ensure the other team member accomplished his/her tasks. Would you consider this amount of work:

(Circle one)
5 - Above Average
4 - Slightly Above Average
3 - Average
2 - Slightly Below Average
1 - Below Average

8.5 Indicate the number of times you did not hear or did not understand what was said by the other team member. (If none, write 0.) __________

8.6 Indicate the number of times you voiced disagreement with what the other team member said. (If none, write 0.) __________

8.7 Indicate the number of times you questioned the accuracy of, or corrected, information provided by the other team member. (If none, write 0.) __________

8.8 Overall, how good was the teamwork?

0	1	2	3	4	5	6	7
Unsatisfactory							Excellent

9. DYSIM FEEDBACK

Please compare the frequency of **team communications** generated during the DYSIM problem you just completed with the level that you would experience working live traffic, given the same teammate, problem, workload, and time period. For example, if there were more team commands given than normal during the DYSIM problem, you would circle "4" for "Commands."

		Far Fewer...		About the Same...		Many More
9.1	Praising the other's work.	1	2	3	4	5
9.2	Giving commands/requesting action.	1	2	3	4	5
9.3	Asking for factual information.	1	2	3	4	5
9.4	Asking about what the other plans to do.	1	2	3	4	5

Continued . . .

TEAM COMMUNICATION (Continued)

9. DYSIM FEEDBACK (Continued)

		Far Fewer...About the Same...Many More				
9.5	Making observations about the situation.	1	2	3	4	5
9.6	Making suggestions.	1	2	3	4	5
9.7	Stating what you intend to do.	1	2	3	4	5
9.8	Verbally indicating to the other that you heard.	1	2	3	4	5
9.9	Supplying information in answer to other's questions.	1	2	3	4	5
9.10	Indicating you agree with something said.	1	2	3	4	5
9.11	Indicating you disagree with something said.	1	2	3	4	5
9.12	Correcting information given to you by the other.	1	2	3	4	5
9.13	Figuring out what was said or meant.	1	2	3	4	5
9.14	Making non-task-related comments.	1	2	3	4	5

10. DEMOGRAPHICS

10.1 How long have you teamed with the other controller who was working the sector with you?

____ years Never teamed before

10.2 If you have teamed before, how long since you last worked together?

1 day 2-3 days About 1 week About 2 weeks More than 2 weeks

GROUND-AIR COMMUNICATION

Code: ______________________ Date: ___________ Session #: ___________

Please think back over the ground-air communication in the air traffic control experience you have just had. Then estimate the number of times you think each of the following events occurred. If the event did not occur, write 0.

As the R-side controller, I:		**Enter Number Of Times This Happened**
1.	Improperly identified center/sector.	___________
2.	Improperly acknowledged a pilot.	___________
3.	Gave a command improperly.	___________
4.	Gave a report (e.g., traffic) improperly.	___________
5.	Missed an incorrect pilot callsign.	___________
6.	Missed an incorrect pilot readback.	___________
7.	Missed an incorrect pilot acknowledgment.	___________
8.	Missed a pilot's failure to acknowledge.	___________
9.	Was uncertain about what a pilot had transmitted.	___________
10.	Corrected a pilot response.	___________

11. Overall, how effective were you in communicating with pilots? That is, transmission time was minimized, information did not have to be repeated, and misunderstandings did not occur.

0	1	2	3	4	5	6	7
Ineffective							Very Effective

Continued . . .

GROUND-AIR COMMUNICATION (Continued)

Please compare the frequency of ground-air communications generated during the DYSIM problem with the level you would experience working live traffic, given the same teammate, problem, workload, and time period. For example, if there were far fewer commands given than normal during the DYSIM problem, you would circle "1" for "Commands".

		Far Fewer...		About the Same...		Many More
12.	Commands.	1	2	3	4	5
13.	Questions.	1	2	3	4	5
14.	Initiating reports (e.g., traffic).	1	2	3	4	5
15.	Acknowledgments.	1	2	3	4	5
16.	Answering questions.	1	2	3	4	5
17.	Correcting pilot statements.	1	2	3	4	5
18.	Figuring out what a pilot said or meant.	1	2	3	4	5
19.	Making non-task-related comments to pilots.	1	2	3	4	5

GROUND-LINE COMMUNICATION

Code: ______________________ Position Worked: R-Side D-Side

Date: ______________________ Session #: ______________________

Please think back over the ground-line communication in the air traffic control experience you have just had. Then estimate the number of times you think each of the following events occurred. If the event did not occur, write 0.

Note: If you did not handle the ground-lines at all, then check here. _______
Do not complete the survey.

Talking on the ground lines, I:	**Enter Number Of Times This Happened**
1. Improperly identified own center/sector.	________
2. Improperly identified center/sector of addressee.	________
3. Improperly made a handoff.	________
4. Improperly gave a pointout.	________
5. Improperly gave a command or requested an action, other than a handoff or pointout.	________
6. Missed incorrect identification of center/sector by addressee.	________
7. Missed incorrect readback.	________
8. Missed incorrect acknowledgment.	________

9. Overall, how effective were you in communicating with other controllers over the ground-lines? That is, transmission time was minimized, information did not have to be repeated, and misunderstandings did not occur.

0	1	2	3	4	5	6	7
Ineffective							Very Effective

Continued . . .

GROUND-LINE COMMUNICATION (Continued)

Please compare the frequency of ground-line communications generated during the DYSIM problem with the levels that you would experience working live traffic, given the same teammate, problem, workload, and time period. For example, if there were about the same number of commands as are normally issued, you would circle "3".

		Far Fewer...		**About the Same...**		**Many More**
10.	Commands.	1	2	3	4	5
11.	Questions.	1	2	3	4	5
12.	Initiating reports (e.g., traffic).	1	2	3	4	5
13.	Acknowledgments.	1	2	3	4	5
14.	Answering questions.	1	2	3	4	5
15.	Correcting controller statements.	1	2	3	4	5
16.	Figuring out what a controller said or meant.	1	2	3	4	5
17.	Making non-task-related comments.	1	2	3	4	5

A-2.0 Summary of Team Communication Turn Frequencies by Team Type (Means)

EXPERT/EXPERT EST.	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	1.9	1.4	3.3	1.3	1.1	2.4	1.6	1.2	2.8
COMMAND	1.0	2.3	3.2	2.5	1.4	3.9	1.7	1.8	3.6
INQUIRY-SITUATION	9.9	15.6	25.5	11.6	9.9	21.5	10.8	12.7	23.5
INQUIRY-INTENT	.6	.5	1.1	.0	.5	.5	.3	.5	.8
OBSERVATION	19.3	22.0	41.3	18.9	22.8	41.6	19.1	22.4	41.5
SUGGESTION	1.5	3.1	4.5	.5	1.8	2.3	1.0	2.4	3.4
STATEMENT OF INTENT	1.4	1.9	3.3	1.5	1.0	2.5	1.4	1.5	2.9
ACKNOWLEDGMENT	8.0	3.1	11.1	4.3	5.8	10.0	6.1	4.4	10.5
ANSWER SUPPLYING INFO.	11.4	9.9	21.3	7.3	10.0	17.3	9.3	9.9	19.3
AGREEMENT	4.0	2.2	6.2	1.3	3.8	5.0	2.6	3.0	5.6
DISAGREEMENT	.9	.6	1.5	1.0	.3	1.3	.9	.4	1.4
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	3.7	2.5	6.2	2.8	1.0	3.8	3.2	1.7	5.0
NON-TASK-RELATED COMMENT	16.7	17.7	34.4	20.0	21.4	41.4	18.4	19.5	37.9
NONCODABLE	4.3	6.7	11.0	7.5	4.5	12.0	5.9	5.6	11.5
TOTALS	85	89	174	80	85	165	82	87	170

EXPERT/EXPERT NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	1.5	.0	1.5	1.3	.5	1.8	1.4	.3	1.6
COMMAND	1.5	1.5	3.0	1.0	1.0	2.0	1.3	1.3	2.5
INQUIRY-SITUATION	17.3	7.3	24.5	6.0	6.5	12.5	11.6	6.9	18.5
INQUIRY-INTENT	.5	.5	1.0	.5	.5	1.0	.5	.5	1.0
OBSERVATION	26.5	30.5	57.0	10.0	14.8	24.8	18.3	22.6	40.9
SUGGESTION	1.0	.0	1.0	.5	6.5	7.0	.8	3.3	4.0
STATEMENT OF INTENT	.8	.8	1.5	2.3	.0	2.3	1.5	.4	1.9
ACKNOWLEDGMENT	6.5	9.0	15.5	5.5	4.5	10.0	6.0	6.8	12.8
ANSWER SUPPLYING INFO.	5.5	16.8	22.3	5.5	3.3	8.8	5.5	10.0	15.5
AGREEMENT	5.0	5.0	10.0	4.5	2.5	7.0	4.8	3.8	8.5
DISAGREEMENT	.5	.5	1.0	.0	.5	.5	.3	.5	.8
RESPONSE CORRECTING INFO.	.5	.5	1.0	.0	.0	.0	.3	.3	.5
RESPONSE UNCERTAINTY	.5	1.8	2.3	2.0	2.0	4.0	1.3	1.9	3.1
NON-TASK-RELATED COMMENT	23.0	16.5	39.5	25.5	27.5	53.0	24.3	22.0	46.3
NONCODABLE	5.5	4.5	10.0	11.0	6.0	17.0	8.3	5.3	13.5
TOTALS	96	95	191	76	76	152	86	86	171

Summary of Team Communication Turn Frequencies by Team Type (Means)

EXPERT/INTERMEDIATE EST.	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	1.9	1.4	3.3	2.1	1.6	3.7	2.0	1.5	3.5
COMMAND	1.9	2.2	4.1	1.3	2.3	3.5	1.6	2.2	3.8
INQUIRY-SITUATION	13.1	8.7	21.8	14.9	9.6	24.5	14.0	9.2	23.2
INQUIRY-INTENT	.0	1.1	1.1	.0	1.3	1.3	.0	1.2	1.2
OBSERVATION	18.9	20.0	38.9	16.4	23.4	39.8	17.7	21.7	39.4
SUGGESTION	.9	3.0	3.9	.5	1.3	1.8	.7	2.1	2.8
STATEMENT OF INTENT	3.1	1.4	4.5	2.2	2.4	4.6	2.7	1.9	4.5
ACKNOWLEDGMENT	6.6	4.5	11.1	7.6	5.0	12.6	7.1	4.8	11.8
ANSWER SUPPLYING INFO.	7.2	12.0	19.2	8.0	12.6	20.6	7.6	12.3	19.9
AGREEMENT	1.1	2.0	3.1	1.3	1.4	2.8	1.2	1.7	2.9
DISAGREEMENT	.1	.3	.4	.2	.1	.3	.2	.2	.3
RESPONSE CORRECTING INFO.	.0	.4	.4	.3	.3	.6	.2	.3	.5
RESPONSE UNCERTAINTY	2.4	1.4	3.8	2.6	1.6	4.3	2.5	1.5	4.0
NON-TASK-RELATED COMMENT	7.6	6.6	14.3	7.5	6.3	13.8	7.6	6.4	14.0
NONCODABLE	5.1	4.0	9.1	3.4	2.8	6.1	4.3	3.4	7.6
TOTALS	70	69	139	68	72	140	69	70	140

EXPERT/INTERMEDIATE NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	1.4	1.4	2.8	3.0	1.5	4.5	2.2	1.4	3.6
COMMAND	.8	1.3	2.0	3.1	.3	3.4	1.9	.8	2.7
INQUIRY-SITUATION	15.6	7.3	22.9	15.4	7.9	23.3	15.5	7.6	23.1
INQUIRY-INTENT	.8	.8	1.5	.0	.5	.5	.4	.6	1.0
OBSERVATION	22.1	26.5	48.6	12.5	27.0	39.5	17.3	26.8	44.1
SUGGESTION	1.3	2.5	3.8	.6	2.0	2.6	.9	2.3	3.2
STATEMENT OF INTENT	5.9	1.1	7.0	2.4	1.3	3.6	4.1	1.2	5.3
ACKNOWLEDGMENT	10.0	4.5	14.5	7.8	3.5	11.3	8.9	4.0	12.9
ANSWER SUPPLYING INFO.	6.8	14.0	20.8	7.4	12.4	19.8	7.1	13.2	20.3
AGREEMENT	2.4	2.3	4.6	1.9	2.5	4.4	2.1	2.4	4.5
DISAGREEMENT	.0	.5	.5	.0	.0	.0	.0	.3	.3
RESPONSE CORRECTING INFO.	.0	.0	.0	.3	1.0	1.3	.1	.5	.6
RESPONSE UNCERTAINTY	2.6	1.5	4.1	1.0	1.8	2.8	1.8	1.6	3.4
NON-TASK-RELATED COMMENT	5.0	4.5	9.5	4.8	4.3	9.0	4.9	4.4	9.3
NONCODABLE	6.3	2.5	8.8	3.8	2.3	6.0	5.0	2.4	7.4
TOTALS	81	71	151	64	68	132	72	69	142

Summary of Team Communication Turn Frequencies by Team Type (Means)

INTERMEDIATE/INT. EST	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	2.5	1.5	4.0	2.2	1.7	3.9	2.4	1.6	4.0
COMMAND	4.0	2.3	6.3	5.2	3.0	8.2	4.6	2.6	7.2
INQUIRY-SITUATION	8.9	12.3	21.1	14.6	11.6	26.2	11.7	11.9	23.7
INQUIRY-INTENT	.3	1.3	1.5	.3	1.1	1.3	.3	1.2	1.4
OBSERVATION	15.4	21.8	37.1	18.0	21.7	39.7	16.7	21.7	38.4
SUGGESTION	1.3	3.8	5.0	1.8	3.7	5.5	1.5	3.7	5.2
STATEMENT OF INTENT	2.9	2.3	5.1	3.8	2.8	6.6	3.4	2.5	5.9
ACKNOWLEDGMENT	5.0	3.8	8.8	5.7	5.0	10.6	5.3	4.4	9.7
ANSWER SUPPLYING INFO.	10.4	8.0	18.4	10.2	12.1	22.3	10.3	10.0	20.3
AGREEMENT	4.0	2.5	6.5	1.6	4.2	5.7	2.8	3.3	6.1
DISAGREEMENT	.3	.3	.5	.4	.5	.9	.3	.4	.7
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.3	.3	.0	.1	.1
RESPONSE UNCERTAINTY	3.5	3.5	7.0	2.8	3.1	5.9	3.2	3.3	6.4
NON-TASK-RELATED COMMENT	6.5	7.0	13.5	7.6	6.4	13.9	7.0	6.7	13.7
NONCODABLE	1.8	.8	2.5	2.0	2.0	4.0	1.9	1.4	3.3
TOTALS	67	71	137	76	79	155	71	75	146

INTERMEDIATE/INT. NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	1.5	1.3	2.8	2.0	1.5	3.5	1.8	1.4	3.1
COMMAND	4.3	2.0	6.3	4.8	2.3	7.0	4.5	2.1	6.6
INQUIRY-SITUATION	16.5	9.5	26.0	10.0	10.3	20.3	13.3	9.9	23.1
INQUIRY-INTENT	.0	.5	.5	.0	.5	.5	.0	.5	.5
OBSERVATION	18.0	22.8	40.8	14.8	21.0	35.8	16.4	21.9	38.3
SUGGESTION	3.5	1.3	4.8	.0	2.5	2.5	1.8	1.9	3.6
STATEMENT OF INTENT	2.8	1.5	4.3	2.5	2.5	5.0	2.6	2.0	4.6
ACKNOWLEDGMENT	6.0	4.0	10.0	6.5	1.0	7.5	6.3	2.5	8.8
ANSWER SUPPLYING INFO.	6.0	15.3	21.3	9.5	9.0	18.5	7.8	12.1	19.9
AGREEMENT	2.5	4.0	6.5	5.5	2.0	7.5	4.0	3.0	7.0
DISAGREEMENT	1.0	.5	1.5	.5	.0	.5	.8	.3	1.0
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.5	.5	.0	.3	.3
RESPONSE UNCERTAINTY	3.5	.5	4.0	2.0	1.5	3.5	2.8	1.0	3.8
NON-TASK-RELATED COMMENT	1.5	3.5	5.0	6.5	4.0	10.5	4.0	3.8	7.8
NONCODABLE	7.0	3.5	10.5	3.0	3.0	6.0	5.0	3.3	8.3
TOTALS	74	70	144	68	62	129	71	66	137

Summary of Team Communication Turn Frequencies by Team Type (Means)

NOVICE/NOVICE NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	3.9	1.4	5.3	2.5	1.4	4.0	3.2	1.4	4.6
COMMAND	4.1	5.5	9.6	4.8	2.3	7.1	4.4	3.9	8.3
INQUIRY-SITUATION	13.3	11.3	24.6	17.7	13.2	30.9	15.5	12.3	27.8
INQUIRY-INTENT	.1	1.1	1.2	.1	.6	.8	.1	.9	1.0
OBSERVATION	19.1	19.4	38.5	18.8	22.2	41.0	19.0	20.8	39.8
SUGGESTION	.8	4.3	5.1	.6	4.7	5.3	.7	4.5	5.2
STATEMENT OF INTENT	2.0	1.2	3.2	2.1	1.1	3.1	2.0	1.1	3.2
ACKNOWLEDGMENT	5.4	5.4	10.8	4.6	5.5	10.1	5.0	5.5	10.5
ANSWER SUPPLYING INFO.	8.3	10.3	18.6	8.8	11.9	20.6	8.5	11.1	19.6
AGREEMENT	2.9	2.2	5.1	2.3	2.0	4.3	2.6	2.1	4.7
DISAGREEMENT	.5	.8	1.3	.1	.3	.4	.3	.5	.8
RESPONSE CORRECTING INFO.	.1	.0	.1	.0	.5	.5	.1	.3	.3
RESPONSE UNCERTAINTY	2.8	1.1	3.8	2.1	2.0	4.1	2.4	1.5	4.0
NON-TASK-RELATED COMMENT	3.1	2.8	5.9	1.7	1.3	2.9	2.4	2.0	4.4
NONCODABLE	3.6	2.4	6.0	4.4	3.4	7.8	4.0	2.9	6.9
TOTALS	70	69	139	71	72	143	70	71	141

NOVICE/NOVICE 2ND NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COURTESY COMMENT	2.6	2.0	4.6	2.4	.5	2.9	2.5	1.3	3.8
COMMAND	4.0	3.4	7.4	5.4	2.1	7.5	4.7	2.8	7.4
INQUIRY-SITUATION	19.9	9.6	29.5	13.3	14.9	28.1	16.6	12.3	28.8
INQUIRY-INTENT	.3	.8	1.0	.0	.8	.8	.1	.8	.9
OBSERVATION	20.4	19.5	39.9	16.3	24.8	41.0	18.3	22.1	40.4
SUGGESTION	1.1	7.8	8.9	1.4	6.6	8.0	1.3	7.2	8.4
STATEMENT OF INTENT	2.3	2.1	4.4	2.8	1.4	4.1	2.5	1.8	4.3
ACKNOWLEDGMENT	8.9	4.3	13.1	6.8	7.8	14.5	7.8	6.0	13.8
ANSWER SUPPLYING INFO.	5.5	19.9	25.4	10.3	10.6	20.9	7.9	15.3	23.1
AGREEMENT	3.6	2.5	6.1	3.3	2.3	5.5	3.4	2.4	5.8
DISAGREEMENT	1.1	.8	1.9	1.3	.8	2.0	1.2	.8	1.9
RESPONSE CORRECTING INFO.	.0	.3	.3	.0	.3	.3	.0	.3	.3
RESPONSE UNCERTAINTY	3.4	1.0	4.4	1.3	1.0	2.3	2.3	1.0	3.3
NON-TASK-RELATED COMMENT	1.5	1.0	2.5	1.5	1.5	3.0	1.5	1.3	2.8
NONCODABLE	5.5	2.0	7.5	9.1	3.1	12.3	7.3	2.6	9.9
TOTALS	80	77	157	75	78	163	77	78	155

A-2.1 Summary of Controller Communication Turn Frequencies by Established and New Teams

Mean Number of Speech Turns Per Session for Established Teams

EXPERT/EXPERT EST. (EEE)

	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
TEAM COMM. ON TASK	63.5	65.1	128.5	52.8	59.1	111.9	58.1	62.1	120.2
TC NON-TASK-RELATED	16.7	17.7	34.4	20.0	21.4	41.4	18.4	19.5	37.9
TC NONCODABLE	4.3	6.7	11.0	7.5	4.5	12.0	5.9	5.6	11.5
GROUND-AIR COMM.	71.7	.0	71.7	93.3	.0	93.3	82.5	.0	82.5
GA NONCODABLE	.0	.0	.0	.5	.0	.5	.3	.0	.3
GROUND-LINE COMM.	.5	28.9	29.4	.0	30.3	30.3	.3	29.6	29.8
GL NONCODABLE	.0	1.2	1.2	.0	.5	.5	.0	.8	.8

EXPERT/INT. EST. (EIE)

	MODERATE			HEAVY			COMBINED		
TEAM COMM. ON TASK	57.4	58.3	115.6	57.3	62.9	120.1	57.3	60.6	117.9
TC NON-TASK-RELATED	7.6	6.6	14.3	7.5	6.3	13.8	7.6	6.4	14.0
TC NONCODABLE	5.1	4.0	9.1	3.4	2.8	6.1	4.3	3.4	7.6
GROUND-AIR COMM.	80.7	.0	80.7	101	.0	101.6	91.2	.0	91.2
GA NONCODABLE	.3	.0	.3	.4	.0	.4	.3	.0	.3
GROUND-LINE COMM.	.1	33.1	33.3	.0	43.5	43.5	.1	38.3	38.4
GL NONCODABLE	.0	.4	.4	.0	.3	.3	.0	.3	.3

INT./INT. EST. (IIE)

	MODERATE			HEAVY			COMBINED		
TEAM COMM. ON TASK	58.3	63.0	121.3	66.5	70.7	137.2	62.4	66.8	129.2
TC NON-TASK-RELATED	6.5	7.0	13.5	7.6	6.4	13.9	7.0	6.7	13.7
TC NONCODABLE	1.8	.8	2.5	2.0	2.0	4.0	1.9	1.4	3.3
GROUND-AIR COMM.	77.5	.0	77.5	99.9	.0	99.9	88.7	.0	88.7
GA NONCODABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND-LINE COMM.	.0	33.8	33.8	.0	40.1	40.1	.0	36.9	36.9
GL NONCODABLE	.0	.3	.3	.0	.8	.8	.0	.5	.5

Summary of Controller Communication Turn Frequencies by Established and New Teams

Mean Number of Speech Turns Per Session for New Teams

	MODERATE			HEAVY			COMBINED		
EXPERT/EXPERT NEW (EEN)	RSIDE	DSIDE	TOTAL	RSIDE	DSIDE	TOTAL	RSIDE	DSIDE	TOTAL
TEAM COMM. ON TASK	67.5	74.0	141.5	39.0	42.5	81.5	53.3	58.3	111.5
TC NON-TASK-RELATED	23.0	16.5	39.5	25.5	27.5	53.0	24.3	22.0	46.3
TC NONCODABLE	5.5	4.5	10.0	11.0	6.0	17.0	8.3	5.3	13.5
GROUND-AIR COMM.	84.0	.0	84.0	84.0	.0	84.0	84.0	.0	84.0
GA NONCODABLE	.5	.0	.5	.0	.0	.0	.3	.0	.3
GROUND-LINE COMM.	.0	31.0	31.0	.0	25.0	25.0	.0	28.0	28.0
GL NONCODABLE	.0	1.5	1.5	.0	1.0	1.0	.0	1.3	1.3
EXPERT/INT. NEW (EIN)									
TEAM COMM. ON TASK	69.5	63.5	133.0	55.3	61.5	116.8	62.4	62.5	124.9
TC NON-TASK-RELATED	5.0	4.5	9.5	4.8	4.3	9.0	4.9	4.4	9.3
TC NONCODABLE	6.3	2.5	8.8	3.8	2.3	6.0	5.0	2.4	7.4
GROUND-AIR COMM.	90.2	.0	90.2	102.5	.0	102.5	96.3	.0	96.3
GA NONCODABLE	.3	.0	.3	.8	.0	.8	.5	.0	.5
GROUND-LINE COMM.	.0	38.5	38.5	.0	41.8	41.8	.0	40.1	40.1
GL NONCODABLE	.0	.5	.5	.0	.3	.3	.0	.4	.4
INT./INT. NEW (IIN)									
TEAM COMM. ON TASK	65.5	63.0	128.5	58.0	54.5	112.5	61.8	58.8	120.5
TC NON-TASK-RELATED	1.5	3.5	5.0	6.5	4.0	10.5	4.0	3.8	7.8
TC NONCODABLE	7.0	3.5	10.5	3.0	3.0	6.0	5.0	3.3	8.3
GROUND-AIR COMM.	93.0	.0	93.0	104.0	.0	104.0	98.5	.0	98.5
GA NONCODABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND-LINE COMM.	.0	40.5	40.5	.0	46.5	46.5	.0	43.5	43.5
GL NONCODABLE	.0	2.0	2.0	.0	.0	.0	.0	1.0	1.0
NOVICE/NOVICE NEW (NNE)									
TEAM COMM. ON TASK	63.1	64.0	127.1	64.7	67.7	132.3	63.9	65.8	129.7
TC NON-TASK-RELATED	3.1	2.8	5.9	1.7	1.3	2.9	2.4	2.0	4.4
TC NONCODABLE	3.6	2.4	6.0	4.4	3.4	7.8	4.0	2.9	6.9
GROUND-AIR COMM.	67.0	.0	67.0	81.5	.0	81.5	74.3	.0	74.3
GA NONCODABLE	.1	.0	.1	.4	.0	.4	.3	.0	.3
GROUND-LINE COMM.	.0	34.9	34.9	.0	40.4	40.4	.0	37.6	37.6
GL NONCODABLE	.0	.0	.0	.0	.1	.1	.0	.1	.1
NOV./NOV. 2ND NEW (NNN)									
TEAM COMM. ON TASK	73.0	73.8	146.8	64.1	73.6	137.8	68.6	73.7	142.3
NON-TASK-RELATED COMMENT	1.5	1.0	2.5	1.5	1.5	3.0	1.5	1.3	2.8
NONCODABLE	5.5	2.0	7.5	9.1	3.1	12.3	7.3	2.6	9.9
GROUND-AIR COMMUNICATION	74.3	.0	74.3	81.8	.0	81.8	78.0	.0	78.0
NONCODABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0
GROUND-LINE COMMUNICATION	.0	41.5	41.5	.0	46.5	46.5	.0	44.0	44.0
NONCODABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0

A-3.0 ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	2341.537	334.505	.591	.7621
SIDE	1	194.833	194.833	.344	.5586
WORKLOAD	1	944.031	944.031	1.668	.1992
TEAM TYPE * SIDE	7	151.705	21.672	.038	.9999
TEAM TYPE * W...	7	2680.242	382.892	.676	.6916
SIDE * WORKLOAD	1	87.577	87.577	.155	.6948
TEAM TYPE * SI...	7	156.720	22.389	.040	.9999
Residual	112	63396.870	566.043		

Dependent: TEAM COMM-TASK

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	19.741	2.820	.713	.6612
SIDE	1	20.816	20.816	5.262	.0237
WORKLOAD	1	.103	.103	.026	.8721
TEAM TYPE * SIDE	7	9.706	1.387	.350	.9286
TEAM TYPE * W...	7	10.623	1.518	.384	.9103
SIDE * WORKLOAD	1	.003	.003	.001	.9783
TEAM TYPE * SI...	7	8.082	1.155	.292	.9559
Residual	112	443.096	3.956		

Dependent: COURTESY COMMENT

Means Table
Effect: SIDE
Dependent: COURTESY COMMENT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	2.288	2.169	.256
D-SIDE	72	1.360	1.492	.176

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	182.356	26.051	3.695	.0012
SIDE	1	23.240	23.240	3.297	.0721
WORKLOAD	1	.069	.069	.010	.9214
TEAM TYPE * SIDE	7	37.292	5.327	.756	.6255
TEAM TYPE * W...	7	18.604	2.658	.377	.9141
SIDE * WORKLOAD	1	16.844	16.844	2.389	.1250
TEAM TYPE * SI...	7	29.673	4.239	.601	.7537
Residual	112	789.544	7.049		

Dependent: COMMAND

Means Table

Effect: TEAM TYPE
Dependent: COMMAND

	Count	Mean	Std. Dev.	Std. Error
EEE	16	1.781	1.871	.468
EEN	8	1.250	.886	.313
EIE	32	1.891	1.826	.323
EIN	16	1.344	2.031	.508
IIE	16	3.600	2.853	.713
IIN	8	3.312	1.889	.668
NNE	32	4.175	3.700	.654
NNN	16	3.719	2.863	.716

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: COMMAND
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EEN	EIN	.094	1.971	
	EEE	.531	2.076	
	EIE	.641	2.147	
	IIN	2.062	2.196	
	IIE	2.350	2.238	S
	NNN	2.469	2.266	S
	NNE	2.925	2.295	S
EIN	EEE	.438	1.971	
	EIE	.547	2.076	
	IIN	1.969	2.147	
	IIE	2.256	2.196	S
	NNN	2.375	2.238	S
	NNE	2.831	2.266	S
EEE	EIE	.109	1.971	
	IIN	1.531	2.076	
	IIE	1.819	2.147	
	NNN	1.938	2.196	
	NNE	2.394	2.238	S
EIE	IIN	1.422	1.971	
	IIE	1.709	2.076	
	NNN	1.828	2.147	
	NNE	2.284	2.196	S
IIN	IIE	.287	1.971	
	NNN	.406	2.076	
	NNE	.863	2.147	
IIE	NNN	.119	1.971	
	NNE	.575	2.076	
NNN	NNE	.456	1.971	

S = Significantly different at this level.

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	264.085	37.726	.910	.5013
SIDE	1	306.883	306.883	7.405	.0075
WORKLOAD	1	8.370	8.370	.202	.6540
TEAM TYPE * SIDE	7	273.699	39.100	.943	.4763
TEAM TYPE * W...	7	216.534	30.933	.746	.6332
SIDE * WORKLOAD	1	20.013	20.013	.483	.4885
TEAM TYPE * SI...	7	332.303	47.472	1.145	.3401
Residual	112	4641.619	41.443		

Dependent: INQUIRY-SIT

Means Table
Effect: SIDE
Dependent: INQUIRY-SIT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	14.000	6.446	.760
D-SIDE	72	10.634	6.266	.738

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	1.821	.260	.215	.9812
SIDE	1	9.050	9.050	7.498	.0072
WORKLOAD	1	.550	.550	.456	.5010
TEAM TYPE * SIDE	7	5.181	.740	.613	.7441
TEAM TYPE * W...	7	1.168	.167	.138	.9951
SIDE * WORKLOAD	1	.063	.063	.052	.8204
TEAM TYPE * SI...	7	1.333	.190	.158	.9926
Residual	112	135.185	1.207		

Dependent: INQUIRY-INT

Means Table
Effect: SIDE
Dependent: INQUIRY-INT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	.162	.407	.048
D-SIDE	72	.858	1.372	.162

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	94.110	13.444	.142	.9947
SIDE	1	618.351	618.351	6.511	.0121
WORKLOAD	1	168.134	168.134	1.770	.1860
TEAM TYPE * SIDE	7	166.541	23.792	.251	.9711
TEAM TYPE * W...	7	606.701	86.672	.913	.4995
SIDE * WORKLOAD	1	95.551	95.551	1.006	.3180
TEAM TYPE * SI...	7	136.879	19.554	.206	.9835
Residual	112	10636.638	94.970		

Dependent: OBSERVATION

Means Table
Effect: SIDE
Dependent: OBSERVATION

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	18.001	9.391	1.107
D-SIDE	72	22.247	8.853	1.043

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	104.139	14.877	2.716	.0122
SIDE	1	156.631	156.631	28.595	.0001
WORKLOAD	1	.392	.392	.072	.7895
TEAM TYPE * SIDE	7	92.596	13.228	2.415	.0243
TEAM TYPE * W...	7	34.203	4.886	.892	.5154
SIDE * WORKLOAD	1	8.596	8.596	1.569	.2129
TEAM TYPE * SI...	7	41.613	5.945	1.085	.3775
Residual	112	613.482	5.478		

Dependent: SUGGESTION

Means Table
Effect: SIDE
Dependent: SUGGESTION

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	.972	1.130	.133
D-SIDE	72	3.494	3.356	.395

Means Table
Effect: TEAM TYPE
Dependent: SUGGESTION

	Count	Mean	Std. Dev.	Std. Error
EEE	16	1.694	1.940	.485
EEN	8	2.000	2.878	1.018
EIE	32	1.422	1.719	.304
EIN	16	1.594	1.474	.369
IIE	16	2.640	2.578	.645
IIN	8	1.812	1.646	.582
NNE	32	2.600	3.188	.564
NNN	16	4.219	4.778	1.195

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: SUGGESTION
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EIE	EIN	.172	1.737	
	EEE	.272	1.830	
	IIN	.391	1.892	
	EEN	.578	1.936	
	NNE	1.178	1.973	
	IIE	1.218	1.998	
	NNN	2.797	2.023	S
EIN	EEE	.100	1.737	
	IIN	.219	1.830	
	EEN	.406	1.892	
	NNE	1.006	1.936	
	IIE	1.046	1.973	
	NNN	2.625	1.998	S
EEE	IIN	.119	1.737	
	EEN	.306	1.830	
	NNE	.906	1.892	
	IIE	.946	1.936	
	NNN	2.525	1.973	S
IIN	EEN	.188	1.737	
	NNE	.787	1.830	
	IIE	.827	1.892	
	NNN	2.406	1.936	S
EEN	NNE	.600	1.737	
	IIE	.640	1.830	
	NNN	2.219	1.892	S
NNE	IIE	.040	1.737	
	NNN	1.619	1.830	
IIE	NNN	1.579	1.737	

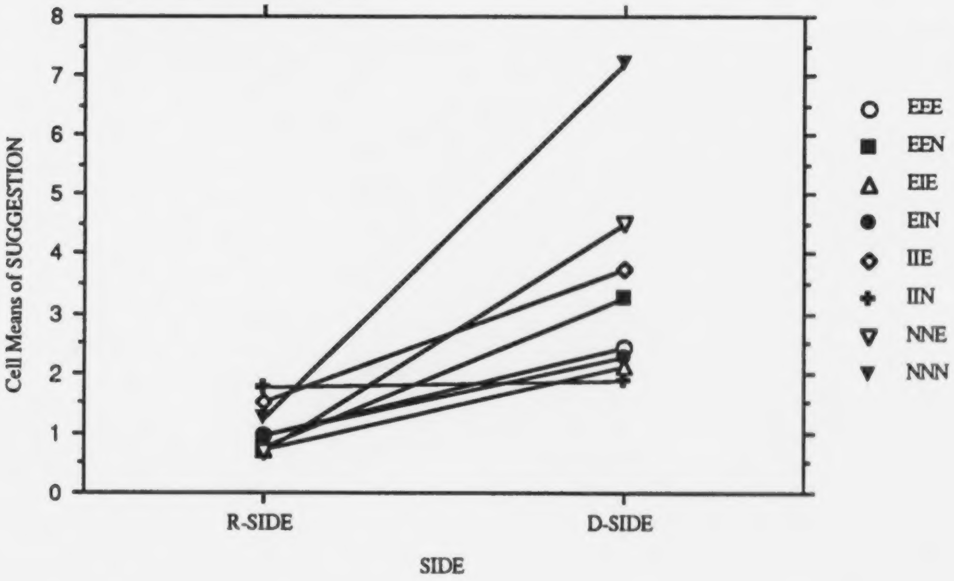
S = Significantly different at this level.

ANOVA's: Team Communication for Team Type

Means Table
Effect: TEAM TYPE * SIDE
Dependent: SUGGESTION

	Count	Mean	Std. Dev.	Std. Error
EEE, R-SIDE	8	.975	1.320	.467
EEE, D-SIDE	8	2.413	2.267	.802
EEN, R-SIDE	4	.750	.957	.479
EEN, D-SIDE	4	3.250	3.775	1.887
EIE, R-SIDE	16	.719	.856	.214
EIE, D-SIDE	16	2.125	2.078	.519
EIN, R-SIDE	8	.938	.943	.333
EIN, D-SIDE	8	2.250	1.669	.590
IIE, R-SIDE	8	1.525	1.700	.601
IIE, D-SIDE	8	3.754	2.918	1.032
IIN, R-SIDE	4	1.750	2.062	1.031
IIN, D-SIDE	4	1.875	1.436	.718
NNE, R-SIDE	16	.688	.602	.151
NNE, D-SIDE	16	4.512	3.583	.896
NNN, R-SIDE	8	1.250	1.309	.463
NNN, D-SIDE	8	7.188	5.203	1.839

Interaction Plot
Effect: TEAM TYPE * SIDE
Dependent: SUGGESTION



ANOVA's: Team Communication for Team Type

Comparison 1
Effect: TEAM TYPE * SIDE
Dependent: SUGGESTION

	Cell Weight
EEE, D-SIDE	-.167
EEN, D-SIDE	-.167
EIE, D-SIDE	-.167
EIN, D-SIDE	-.167
IIE, D-SIDE	-.167
IIN, D-SIDE	-.167
NNE, D-SIDE	.500
NNN, D-SIDE	.500

df	1
Sum of Squares	143.869
Mean Square	143.869
F-Value	26.265
P-Value	.0001

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	43.277	6.182	2.182	.0410
SIDE	1	27.826	27.826	9.819	.0022
WORKLOAD	1	.234	.234	.082	.7746
TEAM TYPE * SIDE	7	20.426	2.918	1.030	.4145
TEAM TYPE * W...	7	14.424	2.061	.727	.6493
SIDE * WORKLOAD	1	.302	.302	.107	.7445
TEAM TYPE * SI...	7	25.219	3.603	1.271	.2709
Residual	112	317.390	2.834		

Dependent: STATEMENT-INT

Means Table
Effect: SIDE
Dependent: STATEMENT-INT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	2.539	2.007	.237
D-SIDE	72	1.569	1.389	.164

Means Table
Effect: TEAM TYPE
Dependent: STATEMENT-INT

	Count	Mean	Std. Dev.	Std. Error
EEE	16	1.456	1.148	.287
EEN	8	.938	.980	.346
EIE	32	2.266	1.955	.346
EIN	16	2.656	2.329	.582
IIE	16	2.938	1.824	.456
IIN	8	2.312	1.907	.674
NNE	32	1.578	1.695	.300
NNN	16	2.125	1.232	.308

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: STATEMENT-INT
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EEN	EEE	.519	1.249	
	NNE	.641	1.316	
	NNN	1.188	1.361	
	EIE	1.328	1.392	
	IIN	1.375	1.419	
	EIN	1.719	1.437	S
	IIE	2.000	1.455	S
EEE	NNE	.122	1.249	
	NNN	.669	1.316	
	EIE	.809	1.361	
	IIN	.856	1.392	
	EIN	1.200	1.419	
	IIE	1.481	1.437	S
NNE	NNN	.547	1.249	
	EIE	.688	1.316	
	IIN	.734	1.361	
	EIN	1.078	1.392	
	IIE	1.359	1.419	
NNN	EIE	.141	1.249	
	IIN	.188	1.316	
	EIN	.531	1.361	
	IIE	.812	1.392	
EIE	IIN	.047	1.249	
	EIN	.391	1.316	
	IIE	.672	1.361	
IIN	EIN	.344	1.249	
	IIE	.625	1.316	
EIN	IIE	.281	1.249	

S = Significantly different at this level.

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	72.780	10.397	.494	.8375
SIDE	1	89.934	89.934	4.270	.0411
WORKLOAD	1	7.747	7.747	.368	.5454
TEAM TYPE * SIDE	7	104.038	14.863	.706	.6672
TEAM TYPE * W...	7	39.211	5.602	.266	.9658
SIDE * WORKLOAD	1	5.800	5.800	.275	.6008
TEAM TYPE * SI...	7	74.750	10.679	.507	.8276
Residual	112	2358.900	21.062		

Dependent: ACKNOWLEDGMENT

Means Table
Effect: SIDE
Dependent: ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	6.493	4.588	.541
D-SIDE	72	4.872	4.059	.478

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	83.580	11.940	.334	.9371
SIDE	1	398.944	398.944	11.143	.0011
WORKLOAD	1	38.045	38.045	1.063	.3048
TEAM TYPE * SIDE	7	198.906	28.415	.794	.5941
TEAM TYPE * W...	7	153.886	21.984	.614	.7433
SIDE * WORKLOAD	1	101.031	101.031	2.822	.0958
TEAM TYPE * SI...	7	343.628	49.090	1.371	.2244
Residual	112	4009.681	35.801		

Dependent: ANSWER SUPP INFO

Means Table
Effect: SIDE
Dependent: ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	8.161	5.188	.611
D-SIDE	72	11.800	6.412	.756

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	77.171	11.024	1.861	.0827
SIDE	1	1.583	1.583	.267	.6062
WORKLOAD	1	3.967	3.967	.669	.4150
TEAM TYPE * SIDE	7	14.188	2.027	.342	.9329
TEAM TYPE * W...	7	4.765	.681	.115	.9972
SIDE * WORKLOAD	1	.380	.380	.064	.8005
TEAM TYPE * SI...	7	48.607	6.944	1.172	.3246
Residual	112	663.657	5.926		

Dependent: AGREEMENT

Means Table
Effect: TEAM TYPE
Dependent: AGREEMENT

	Count	Mean	Std. Dev.	Std. Error
EEE	16	2.800	2.361	.590
EEN	8	4.250	3.024	1.069
EIE	32	1.469	1.539	.272
EIN	16	2.250	2.008	.502
IIE	16	3.050	2.556	.639
IIN	8	3.500	3.338	1.180
NNE	32	2.350	2.638	.466
NNN	16	2.906	2.083	.521

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	9.472	1.353	2.270	.0337
SIDE	1	.199	.199	.333	.5648
WORKLOAD	1	.788	.788	1.321	.2528
TEAM TYPE * SIDE	7	2.893	.413	.693	.6775
TEAM TYPE * W...	7	1.750	.250	.419	.8885
SIDE * WORKLOAD	1	.078	.078	.131	.7183
TEAM TYPE * SI...	7	.534	.076	.128	.9961
Residual	112	66.756	.596		

Dependent: DISAGREEMENT

Means Table
Effect: TEAM TYPE
Dependent: DISAGREEMENT

	Count	Mean	Std. Dev.	Std. Error
EEE	16	.688	.809	.202
EEN	8	.375	.518	.183
EIE	32	.172	.373	.066
EIN	16	.125	.342	.085
IIE	16	.350	.476	.119
IIN	8	.500	.535	.189
NNE	32	.406	.798	.141
NNN	16	.969	1.420	.355

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: DISAGREEMENT
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EIN	EIE	.047	.573	
	IIE	.225	.604	
	EEN	.250	.624	
	NNE	.281	.639	
	IIN	.375	.651	
	EEE	.562	.659	
	NNN	.844	.667	S
EIE	IIE	.178	.573	
	EEN	.203	.604	
	NNE	.234	.624	
	IIN	.328	.639	
	EEE	.516	.651	
	NNN	.797	.659	S
IIE	EEN	.025	.573	
	NNE	.056	.604	
	IIN	.150	.624	
	EEE	.338	.639	
	NNN	.619	.651	
EEN	NNE	.031	.573	
	IIN	.125	.604	
	EEE	.312	.624	
	NNN	.594	.639	
NNE	IIN	.094	.573	
	EEE	.281	.604	
	NNN	.562	.624	
IIN	EEE	.188	.573	
	NNN	.469	.604	
EEE	NNN	.281	.573	

S = Significantly different at this level.

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	1.184	.169	.668	.6988
SIDE	1	.818	.818	3.227	.0751
WORKLOAD	1	.280	.280	1.105	.2954
TEAM TYPE * SIDE	7	.387	.055	.218	.9805
TEAM TYPE * W...	7	1.975	.282	1.113	.3597
SIDE * WORKLOAD	1	.326	.326	1.286	.2592
TEAM TYPE * SI...	7	1.625	.232	.916	.4969
Residual	112	28.376	.253		

Dependent: RESP-CORR

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	31.219	4.460	1.216	.2998
SIDE	1	15.570	15.570	4.246	.0417
WORKLOAD	1	2.736	2.736	.746	.3895
TEAM TYPE * SIDE	7	14.069	2.010	.548	.7962
TEAM TYPE * W...	7	13.430	1.919	.523	.8154
SIDE * WORKLOAD	1	4.676	4.676	1.275	.2612
TEAM TYPE * SI...	7	10.907	1.558	.425	.8850
Residual	112	410.714	3.667		

Dependent: RESP-UNCERT

Means Table
Effect: SIDE
Dependent: RESP-UNCERT

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	2.490	2.127	.251
D-SIDE	72	1.682	1.537	.181

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	5779.621	825.660	23.034	.0001
SIDE	1	6.825	6.825	.190	.6634
WORKLOAD	1	58.331	58.331	1.627	.2047
TEAM TYPE * SIDE	7	20.869	2.981	.083	.9990
TEAM TYPE * W...	7	161.961	23.137	.645	.7174
SIDE * WORKLOAD	1	1.008	1.008	.028	.8671
TEAM TYPE * SI...	7	49.466	7.067	.197	.9855
Residual	112	4014.751	35.846		

Dependent: NON-TASK

Means Table
Effect: TEAM TYPE
Dependent: NON-TASK

	Count	Mean	Std. Dev.	Std. Error
EEE	16	18.956	11.446	2.861
EEN	8	23.125	12.100	4.278
EIE	32	7.000	3.455	.611
EIN	16	4.625	4.256	1.064
IIE	16	6.863	4.169	1.042
IIN	8	3.875	4.016	1.420
NNE	32	2.197	2.681	.474
NNN	16	1.375	1.586	.397

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE

Dependent: NON-TASK
Significance level: .05

	Vs.	Diff.	Crit. diff.	
NNN	NNE	.822	4.444	
	IIN	2.500	4.682	
	EIN	3.250	4.841	
	IIE	5.488	4.952	S
	EIE	5.625	5.047	S
	EEE	17.581	5.111	S
	EEN	21.750	5.174	S
NNE	IIN	1.678	4.444	
	EIN	2.428	4.682	
	IIE	4.666	4.841	
	EIE	4.803	4.952	
	EEE	16.759	5.047	S
	EEN	20.928	5.111	S
IIN	EIN	.750	4.444	
	IIE	2.988	4.682	
	EIE	3.125	4.841	
	EEE	15.081	4.952	S
	EEN	19.250	5.047	S
EIN	IIE	2.238	4.444	
	EIE	2.375	4.682	
	EEE	14.331	4.841	S
	EEN	18.500	4.952	S
IIE	EIE	.137	4.444	
	EEE	12.094	4.682	S
	EEN	16.263	4.841	S
EIE	EEE	11.956	4.444	S
	EEN	16.125	4.682	S
EEE	EEN	4.169	4.444	

S = Significantly different at this level.

ANOVA's: Team Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	226.048	32.293	1.785	.0971
SIDE	1	99.168	99.168	5.482	.0210
WORKLOAD	1	3.738	3.738	.207	.6503
TEAM TYPE * SIDE	7	65.309	9.330	.516	.8210
TEAM TYPE * W...	7	91.148	13.021	.720	.6554
SIDE * WORKLOAD	1	2.078	2.078	.115	.7353
TEAM TYPE * SI...	7	54.507	7.787	.430	.8813
Residual	112	2025.945	18.089		

Dependent: NON-CODE

Means Table
Effect: SIDE
Dependent: NON-CODE

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	72	4.804	5.058	.596
D-SIDE	72	3.186	3.023	.356

Means Table
Effect: TEAM TYPE
Dependent: NON-CODE

	Count	Mean	Std. Dev.	Std. Error
EEE	16	5.750	5.169	1.292
EEN	8	6.750	4.652	1.645
EIE	32	3.812	3.217	.569
EIN	16	3.688	2.575	.644
IIE	16	1.631	1.406	.351
IIN	8	4.125	3.563	1.260
NNE	32	3.444	3.361	.594
NNN	16	4.938	7.713	1.928

ANOVA's: Team Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: NON-CODE
Significance level: .05

	Vs.	Diff.	Crit. diff.	
IIE	NNE	1.812	3.157	
	EIN	2.056	3.326	
	EIE	2.181	3.439	
	IIN	2.494	3.518	
	NNN	3.306	3.585	
	EEE	4.119	3.630	S
	EEN	5.119	3.676	S
NNE	EIN	.244	3.157	
	EIE	.369	3.326	
	IIN	.681	3.439	
	NNN	1.494	3.518	
	EEE	2.306	3.585	
	EEN	3.306	3.630	
EIN	EIE	.125	3.157	
	IIN	.438	3.326	
	NNN	1.250	3.439	
	EEE	2.062	3.518	
	EEN	3.062	3.585	
EIE	IIN	.312	3.157	
	NNN	1.125	3.326	
	EEE	1.938	3.439	
	EEN	2.938	3.518	
IIN	NNN	.812	3.157	
	EEE	1.625	3.326	
	EEN	2.625	3.439	
NNN	EEE	.812	3.157	
	EEN	1.812	3.326	
EEE	EEN	1.000	3.157	

S = Significantly different at this level.

A-4.0 ANOVA's: Team Communication – SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.447	.447	.160	.6907
WORKLOAD	1	.186	.186	.066	.7974
PERFORM-SME ...	1	.552	.552	.197	.6584
Residual	68	190.409	2.800		

Dependent: TC-COURTESY COMMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	80.513	80.513	12.260	.0008
WORKLOAD	1	.229	.229	.035	.8524
PERFORM-SME ...	1	.484	.484	.074	.7868
Residual	68	446.579	6.567		

Dependent: TC-COMMAND

Means Table
Effect: PERFORM-SME
Dependent: TC-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP	36	1.611	2.091	.349
BOTTOM	36	3.750	2.900	.483

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	56.645	56.645	1.053	.3086
WORKLOAD	1	3.251	3.251	.060	.8066
PERFORM-SME ...	1	38.557	38.557	.716	.4003
Residual	68	3659.547	53.817		

Dependent: TC-INQUIRY-SIT

ANOVA's: Team Communication – SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	1.187	1.187	2.459	.1215
WORKLOAD	1	.490	.490	1.016	.3170
PERFORM-SME ...	1	1.647	1.647	3.413	.0690
Residual	68	32.814	.483		

Dependent: TC-INQUIRY-INT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	301.533	301.533	4.530	.0369
WORKLOAD	1	84.285	84.285	1.266	.2644
PERFORM-SME ...	1	29.686	29.686	.446	.5065
Residual	68	4526.698	66.569		

Dependent: TC-OBSERVATION

Means Table
Effect: PERFORM-SME
Dependent: TC-OBSERVATION

	Count	Mean	Std. Dev.	Std. Error
TOP	36	20.819	8.071	1.345
BOTTOM	36	16.222	8.209	1.368

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	21.765	21.765	2.814	.0980
WORKLOAD	1	6.594	6.594	.853	.3591
PERFORM-SME ...	1	1.224	1.224	.158	.6920
Residual	68	525.940	7.734		

Dependent: TC-SUGGESTION

ANOVA's: Team Communication – SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.057	.057	.024	.8774
WORKLOAD	1	14.636	14.636	6.179	.0154
PERFORM-SME ...	1	1.354	1.354	.572	.4522
Residual	68	161.063	2.369		

Dependent: TC-STATEMENT-INT

Means Table
Effect: WORKLOAD
Dependent: TC-STATEMENT-INT

	Count	Mean	Std. Dev.	Std. Error
HEAVY	34	1.412	1.270	.218
MODERATE	38	2.316	1.718	.279

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	2.482	2.482	.133	.7162
WORKLOAD	1	8.688E-5	8.688E-5	4.67E-6	.9983
PERFORM-SME ...	1	10.704	10.704	.575	.4509
Residual	68	1265.904	18.616		

Dependent: TC-ACKNOWLEDGMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	2.515	2.515	.055	.8146
WORKLOAD	1	4.928	4.928	.109	.7428
PERFORM-SME ...	1	5.647	5.647	.124	.7253
Residual	68	3085.498	45.375		

Dependent: TC-ANSWER SUPP INFO

ANOVA's: Team Communication – SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	25.735	25.735	5.807	.0187
WORKLOAD	1	6.159	6.159	1.390	.2426
PERFORM-SME ...	1	6.289	6.289	1.419	.2377
Residual	68	301.335	4.431		

Dependent: TC-AGREEMENT

Means Table
Effect: PERFORM-SME
Dependent: TC-AGREEMENT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	2.694	2.567	.428
BOTTOM	36	1.347	1.539	.257

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	3.415	3.415	4.323	.0414
WORKLOAD	1	2.503	2.503	3.169	.0795
PERFORM-SME ...	1	.511	.511	.646	.4243
Residual	68	53.719	.790		

Dependent: TC-DISAGREEMENT

Means Table
Effect: PERFORM-SME
Dependent: TC-DISAGREEMENT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	.306	.452	.075
BOTTOM	36	.694	1.191	.198

ANOVA's: Team Communication – SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.002	.002	.006	.9377
WORKLOAD	1	2.018	2.018	7.387	.0083
PERFORM-SME ...	1	.048	.048	.177	.6752
Residual	68	18.577	.273		

Dependent: TC-RESP-CORR

Means Table
Effect: WORKLOAD
Dependent: TC-RESP-CORR

	Count	Mean	Std. Dev.	Std. Error
HEAVY	34	.368	.731	.125
MODERATE	38	.026	.162	.026

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	4.956	4.956	1.261	.2655
WORKLOAD	1	.540	.540	.137	.7121
PERFORM-SME ...	1	.277	.277	.070	.7916
Residual	68	267.357	3.932		

Dependent: TC-RESP-UNCERT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	481.261	481.261	12.346	.0008
WORKLOAD	1	198.230	198.230	5.085	.0274
PERFORM-SME ...	1	271.608	271.608	6.968	.0103
Residual	68	2650.723	38.981		

Dependent: TC-NON-TASK

Means Table
Effect: PERFORM-SME
Dependent: TC-NON-TASK

	Count	Mean	Std. Dev.	Std. Error
TOP	36	7.028	8.634	1.439
BOTTOM	36	2.556	3.791	.632

ANOVA's: Team Communication – SME Overall Team Operation

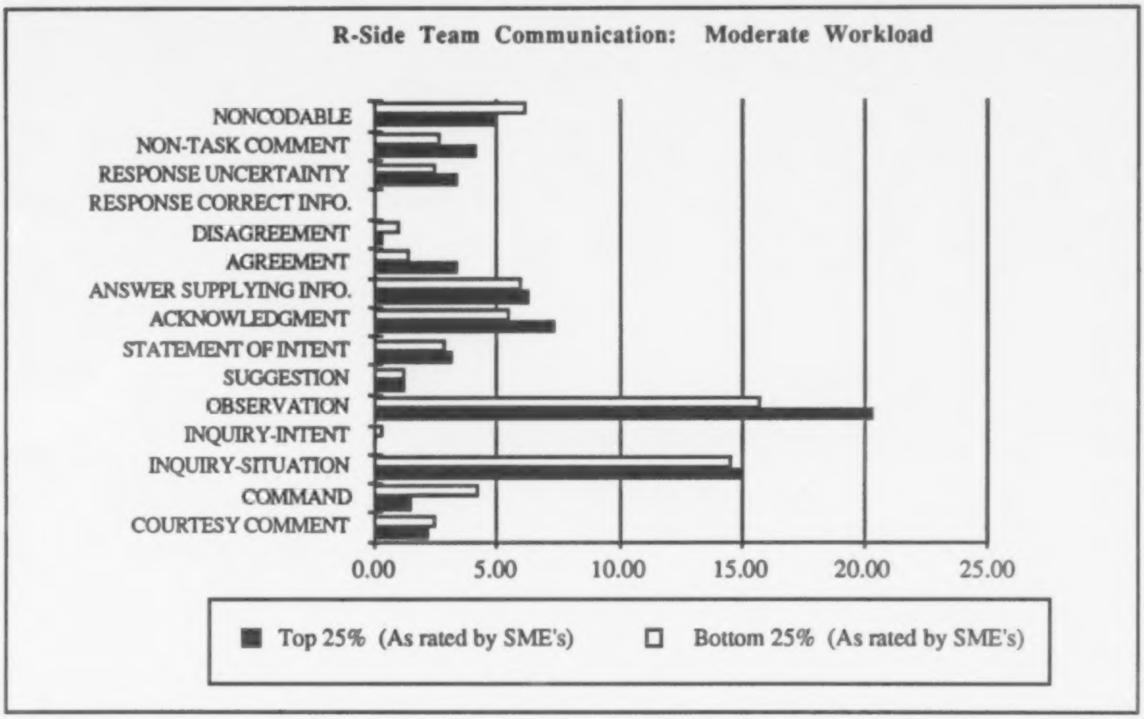
Type III Sums of Squares

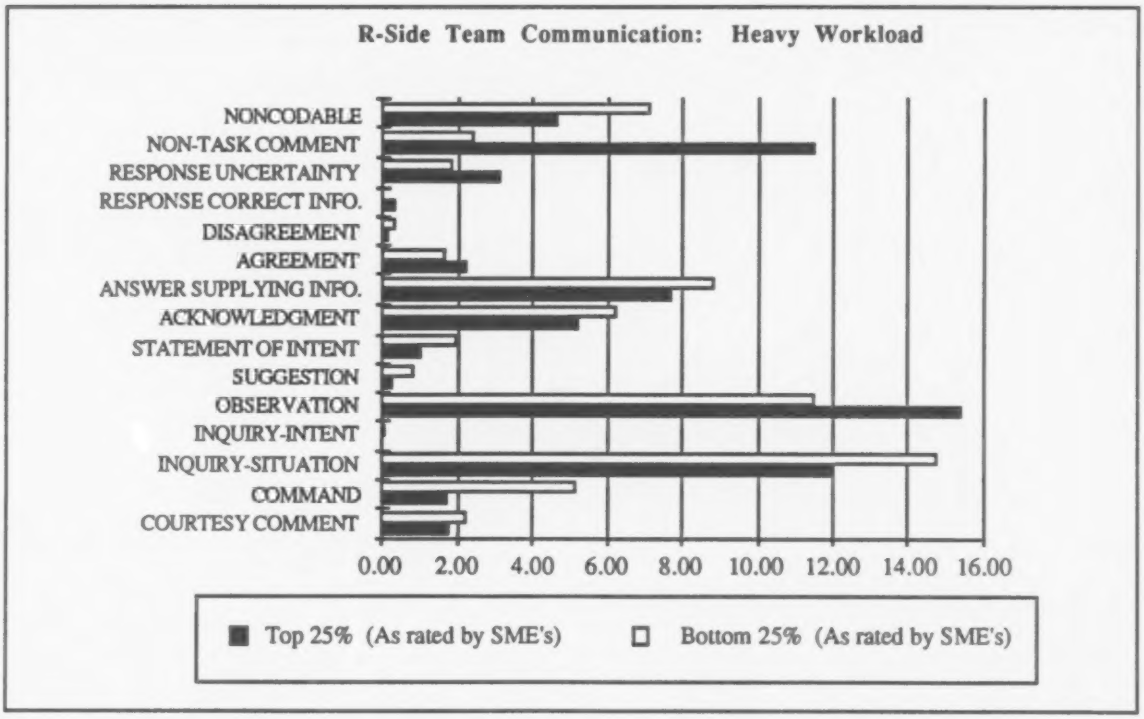
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	2.300	2.300	.096	.7580
WORKLOAD	1	1.671	1.671	.070	.7928
PERFORM-SME ...	1	3.777	3.777	.157	.6930
Residual	68	1633.842	24.027		

Dependent: TC-NON-CODE

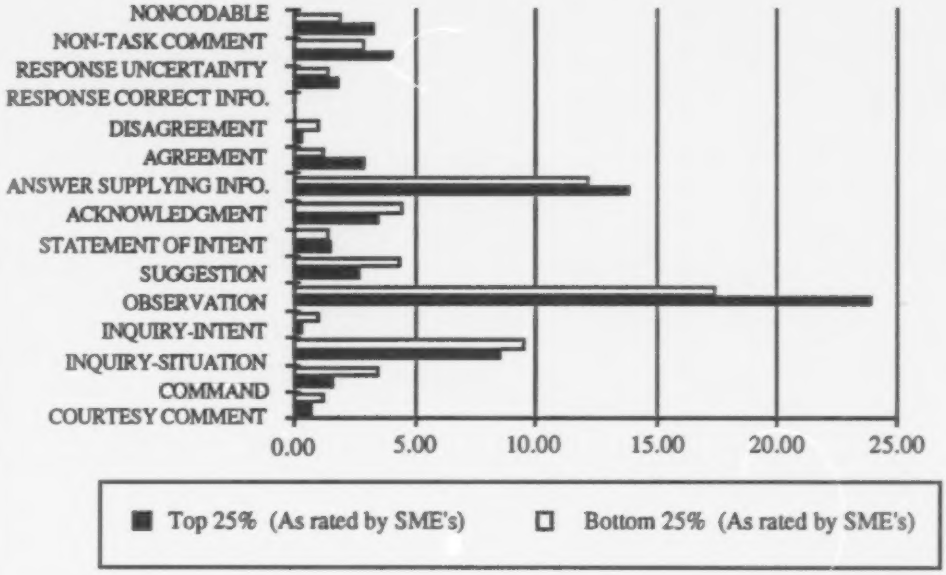
/

A-4.1 Charts of the SME Overall Team Operation Ratings

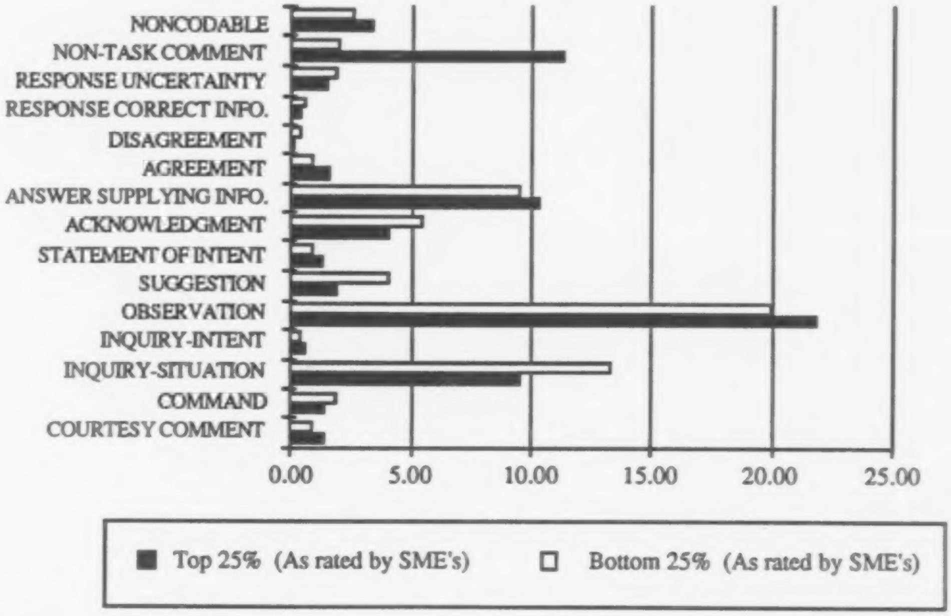




D-Side Team Communication: Moderate Workload



D-Side Team Communication: Heavy Workload



A-5.0 ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	1.009	1.009	.283	.5964
WORKLOAD	1	2.686	2.686	.754	.3883
PERFORM-NONR ...	1	2.686	2.686	.754	.3883
Residual	68	242.300	3.563		

Dependent: TC-COURTESY COMMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	80.460	80.460	17.553	.0001
WORKLOAD	1	2.038	2.038	.445	.5072
PERFORM-NONR ...	1	2.038	2.038	.445	.5072
Residual	68	311.700	4.584		

Dependent: TC-COMMAND

Means Table
Effect: PERFORM-NONR
Dependent: TC-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP	36	1.750	1.713	.286
BOTTOM	36	3.833	2.467	.411

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	646.064	646.064	15.519	.0002
WORKLOAD	1	8.523	8.523	.205	.6524
PERFORM-NONR ...	1	2.387	2.387	.057	.8115
Residual	68	2830.894	41.631		

Dependent: TC-INQUIRY-SIT

Means Table
Effect: PERFORM-NONR
Dependent: TC-INQUIRY-SIT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	10.444	5.294	.882
BOTTOM	36	16.472	7.292	1.215

ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.414	.414	.305	.5825
WORKLOAD	1	1.305	1.305	.963	.3300
PERFORM-NONR ...	1	.001	.001	.001	.9779
Residual	68	92.193	1.356		

Dependent: TC-INQUIRY-INT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	166.936	166.936	2.116	.1504
WORKLOAD	1	56.139	56.139	.711	.4019
PERFORM-NONR ...	1	.834	.834	.011	.9184
Residual	68	5365.665	78.907		

Dependent: TC-OBSERVATION

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	26.118	26.118	3.008	.0874
WORKLOAD	1	.776	.776	.089	.7658
PERFORM-NONR ...	1	16.429	16.429	1.892	.1735
Residual	68	590.500	8.684		

Dependent: TCR-SUGGESTION

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	4.930	4.930	1.573	.2141
WORKLOAD	1	.906	.906	.289	.5927
PERFORM-NONR ...	1	10.744	10.744	3.427	.0685
Residual	68	213.200	3.135		

Dependent: TC-STATEMENT-INT

ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	39.617	39.617	2.190	.1436
WORKLOAD	1	.321	.321	.018	.8944
PERFORM-NONR ...	1	3.178	3.178	.176	.6764
Residual	68	1230.349	18.093		

Dependent: TC-ACKNOWLEDGMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	397.723	397.723	10.748	.0016
WORKLOAD	1	1.450	1.450	.039	.8437
PERFORM-NONR ...	1	.456	.456	.012	.9119
Residual	68	2516.194	37.003		

Dependent: TC-ANSWER SUPP INFO

Means Table
Effect: PERFORM-NONR
Dependent: TC-ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
TOP	36	8.056	4.875	.813
BOTTOM	36	12.778	6.941	1.157

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	4.227E-4	4.227E-4	8.05E-5	.9929
WORKLOAD	1	1.226	1.226	.233	.6305
PERFORM-NONR ...	1	32.568	32.568	6.200	.0152
Residual	68	357.182	5.253		

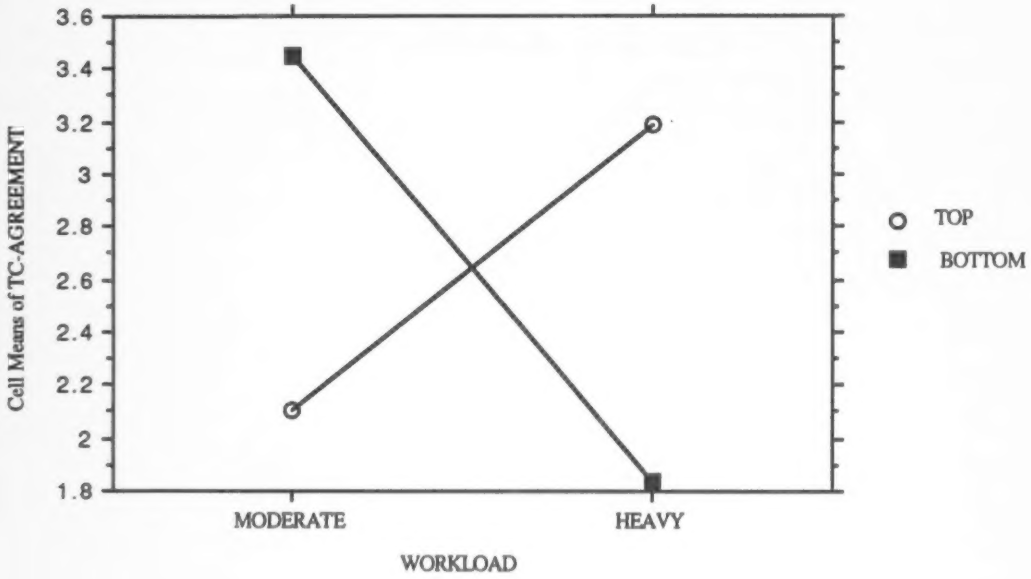
Dependent: TC-AGREEMENT

ANOVA's: Team Nonroutine Communication Performance

Means Table
Effect: PERFORM-NONR * WORKLOAD
Dependent: TC-AGREEMENT

	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	20	2.100	2.553	.571
TOP, HEAVY	16	3.188	2.482	.621
BOTTOM, MODERATE	18	3.444	2.479	.584
BOTTOM, HEAVY	18	1.833	1.465	.345

Interaction Plot
Effect: PERFORM-NONR * WORKLOAD
Dependent: TC-AGREEMENT



ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	7.317	7.317	8.908	.0039
WORKLOAD	1	1.443	1.443	1.757	.1895
PERFORM-NONR ...	1	1.319	1.319	1.605	.2095
Residual	68	55.860	.821		

Dependent: TC-DISAGREEMENT

Means Table
Effect: PERFORM-NONR
Dependent: TC-DISAGREEMENT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	.194	.401	.067
BOTTOM	36	.833	1.231	.205

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.648	.648	3.114	.0821
WORKLOAD	1	1.207	1.207	5.801	.0187
PERFORM-NONR ...	1	.610	.610	2.934	.0913
Residual	68	14.144	.208		

Dependent: TC-RESP-CORR

Means Table
Effect: WORKLOAD
Dependent: TC-RESP-CORR

	Count	Mean	Std. Dev.	Std. Error
MODERATE	38	.053	.226	.037
HEAVY	34	.324	.638	.109

ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	121.442	121.442	42.224	.0001
WORKLOAD	1	4.572	4.572	1.590	.2117
PERFORM-NONR ...	1	6.560	6.560	2.281	.1356
Residual	68	195.578	2.876		

Dependent: TC-RESP-UNCERT

Means Table
Effect: PERFORM-NONR
Dependent: TC-RESP-UNCERT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	.944	1.068	.178
BOTTOM	36	3.556	2.184	.364

ANOVA's: Team Nonroutine Communication Performance

Type III Sums of Squares

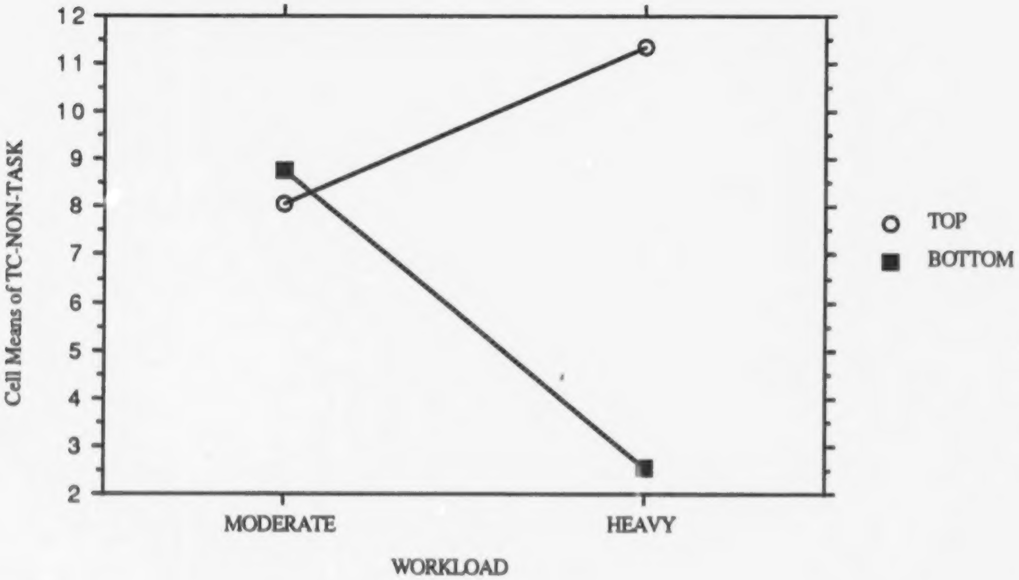
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	292.808	292.808	3.715	.0581
WORKLOAD	1	37.538	37.538	.476	.4925
PERFORM-NONR ...	1	407.625	407.625	5.171	.0261
Residual	68	5360.256	78.827		

Dependent: TC-NON-TASK

Means Table
Effect: PERFORM-NONR * WORKLOAD
Dependent: TC-NON-TASK

	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	20	8.050	9.838	2.200
TOP, HEAVY	16	11.375	11.644	2.911
BOTTOM, MODERATE	18	8.778	8.842	2.084
BOTTOM, HEAVY	18	2.556	3.053	.720

Interaction Plot
Effect: PERFORM-NONR * WORKLOAD
Dependent: TC-NON-TASK



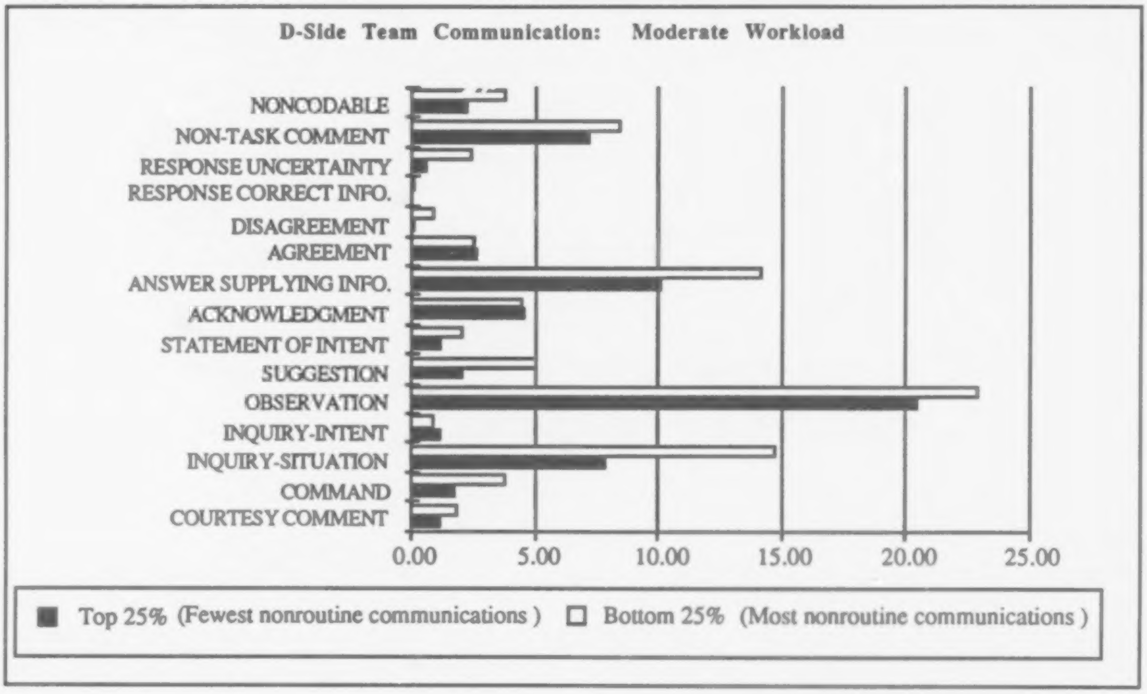
ANOVA's: Team Nonroutine Communication Performance

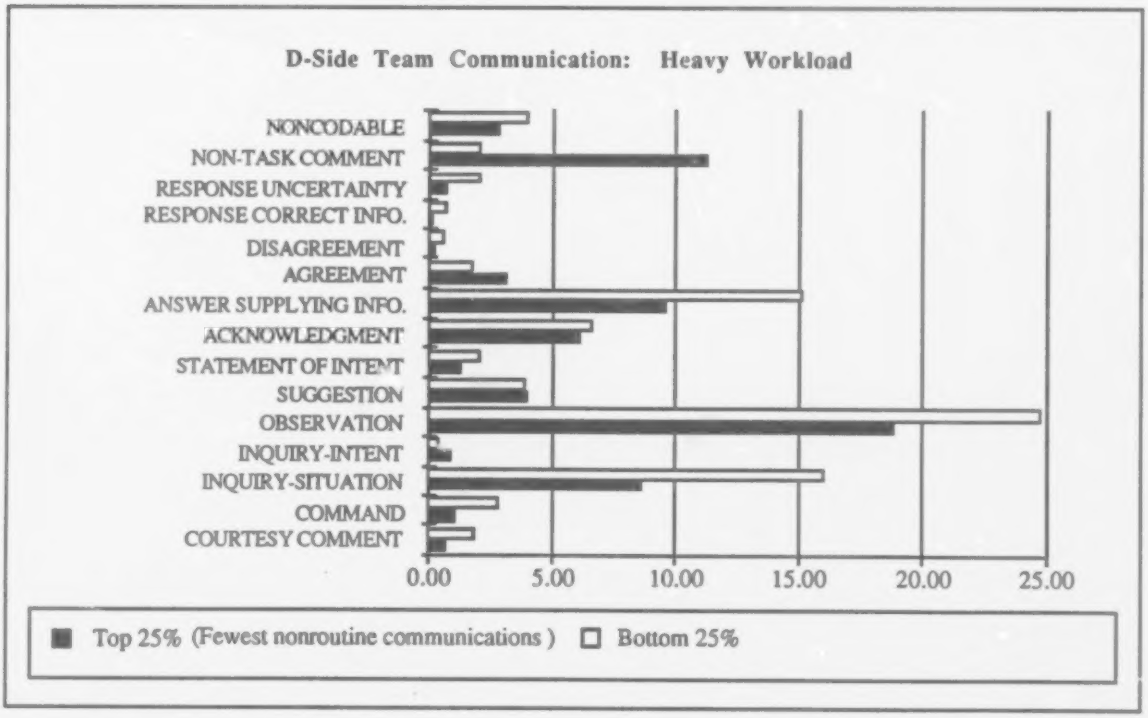
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	65.002	65.002	3.568	.0632
WORKLOAD	1	.026	.026	.001	.9699
PERFORM-NONR ...	1	2.200	2.200	.121	.7293
Residual	68	1238.826	18.218		

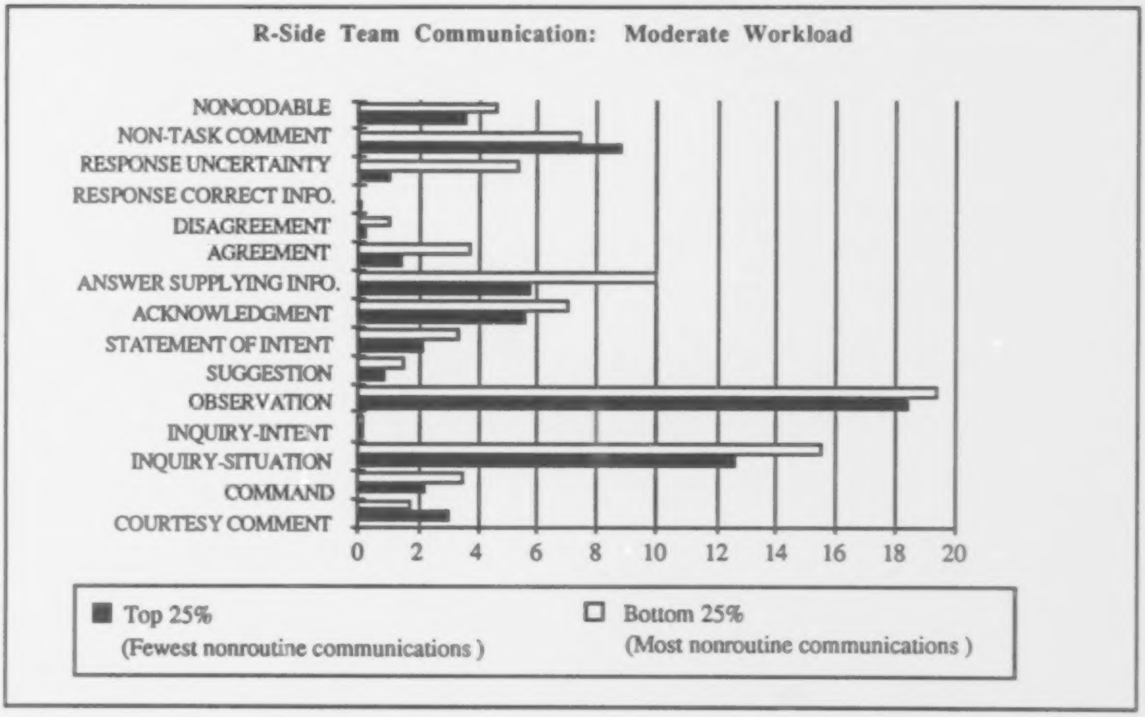
Dependent: TC-NON-CODE

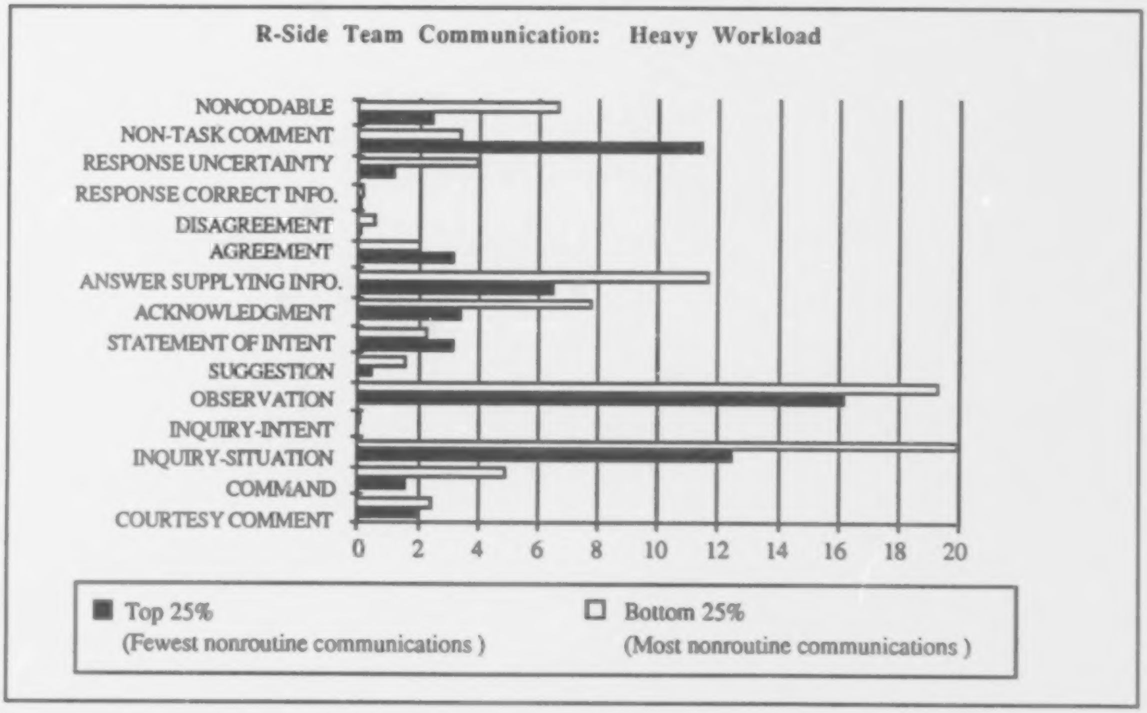
A-5.1 Charts of Team Nonroutine Communication Performance





Charts of Team Nonroutine Communication Performance





A-6.0 ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	7.360	7.360	2.540	.1156
WORKLOAD	1	.693	.693	.239	.6263
PERFORM-INAC ...	1	2.183	2.183	.753	.3885
Residual	68	197.013	2.897		

Dependent: TCR-COURTESY COMMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	6.443	6.443	.642	.4258
WORKLOAD	1	2.554	2.554	.255	.6155
PERFORM-INAC ...	1	6.859	6.859	.683	.4113
Residual	68	682.448	10.036		

Dependent: TCR-COMMAND

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	31.667	31.667	.650	.4231
WORKLOAD	1	17.000	17.000	.349	.5568
PERFORM-INAC ...	1	6.443	6.443	.132	.7173
Residual	68	3315.084	48.751		

Dependent: TCR-INQUIRY-SIT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.196	.196	.124	.7261
WORKLOAD	1	.196	.196	.124	.7261
PERFORM-INAC ...	1	1.697	1.697	1.069	.3049
Residual	68	107.968	1.588		

Dependent: TCR-INQUIRY-INT

ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	3.845	3.845	.042	.8391
WORKLOAD	1	60.678	60.678	.655	.4210
PERFORM-INAC ...	1	75.740	75.740	.818	.3689
Residual	68	6295.026	92.574		

Dependent: TCR-OBSERVATION

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	26.597	26.597	2.594	.1119
WORKLOAD	1	6.375	6.375	.622	.4331
PERFORM-INAC ...	1	.012	.012	.001	.9733
Residual	68	697.169	10.252		

Dependent: TCR-SUGGESTION

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	10.916	10.916	3.481	.0664
WORKLOAD	1	.416	.416	.133	.7169
PERFORM-INAC ...	1	.488	.488	.156	.6945
Residual	68	213.208	3.135		

Dependent: TCR-STATEMENT-INT

Means Table
Effect: PERFORM-INAC
Dependent: TCR-STATEMENT-INT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	2.556	2.063	.344
BOTTOM	36	1.722	1.365	.228

ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.247	.247	.013	.9091
WORKLOAD	1	11.914	11.914	.633	.4289
PERFORM-INAC ...	1	6.308	6.308	.335	.5645
Residual	68	1279.084	18.810		

Dependent: TCR-ACKNOWLEDGMENT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	26.183	26.183	.664	.4180
WORKLOAD	1	82.183	82.183	2.084	.1534
PERFORM-INAC ...	1	26.183	26.183	.664	.4180
Residual	68	2681.383	39.432		

Dependent: TCR-ANSWER SUPP INFO

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	10.916	10.916	1.939	.1683
WORKLOAD	1	12.193	12.193	2.166	.1457
PERFORM-INAC ...	1	.018	.018	.003	.9550
Residual	68	382.844	5.630		

Dependent: TCR-AGREEMENT

ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	3.191	3.191	4.887	.0304
WORKLOAD	1	.080	.080	.122	.7281
PERFORM-INAC ...	1	.274	.274	.420	.5190
Residual	68	44.396	.653		

Dependent: TCR-DISAGREEMENT

Means Table
Effect: PERFORM-INAC
Dependent: TCR-DISAGREEMENT

	Count	Mean	Std. Dev.	Std. Error
TOP	36	.250	.439	.073
BOTTOM	36	.667	1.042	.174

ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

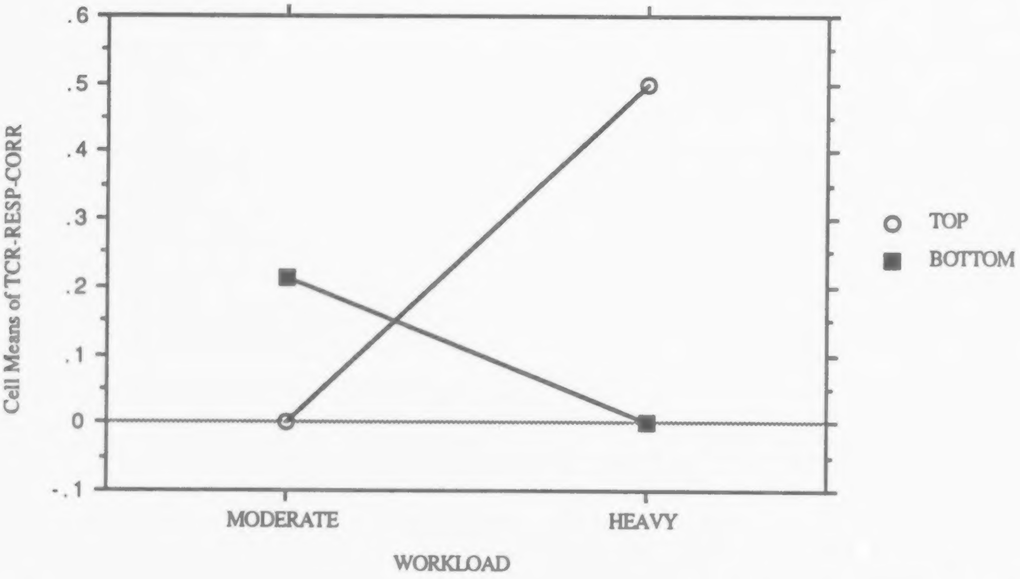
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.349	.349	3.022	.0867
WORKLOAD	1	.349	.349	3.022	.0867
PERFORM-INAC ...	1	2.183	2.183	18.889	.0001
Residual	68	7.857	.116		

Dependent: TCR-RESP-CORR

Means Table
Effect: PERFORM-INAC * WORKLOAD
Dependent: TCR-RESP-CORR

	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	22	0.000	0.000	0.000
TOP, HEAVY	14	.500	.650	.174
BOTTOM, MODERATE	14	.214	.426	.114
BOTTOM, HEAVY	22	0.000	0.000	0.000

Interaction Plot
Effect: PERFORM-INAC * WORKLOAD
Dependent: TCR-RESP-CORR



ANOVA's: Team Communication Inaccuracy Performance

Type III Sums of Squares

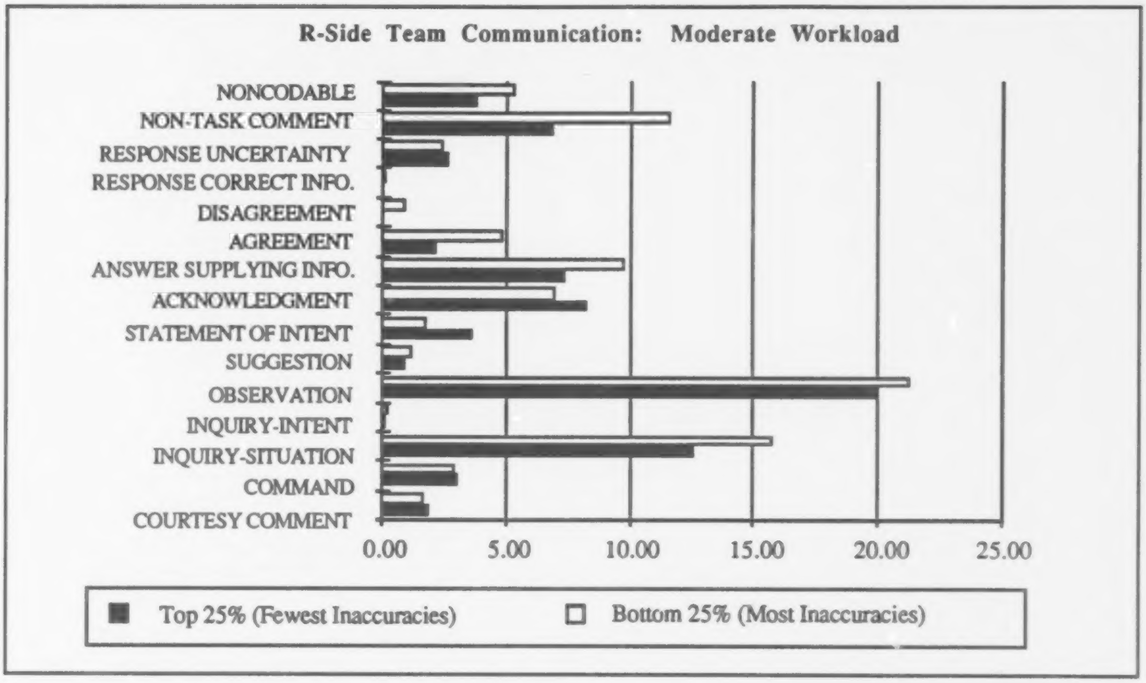
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.058		.018	.8949
WORKLOAD	1	4.058	4.058	1.222	.2729
PERFORM-INAC ...	1	3.336	3.336	1.004	.3198
Residual	68	225.883	3.322		

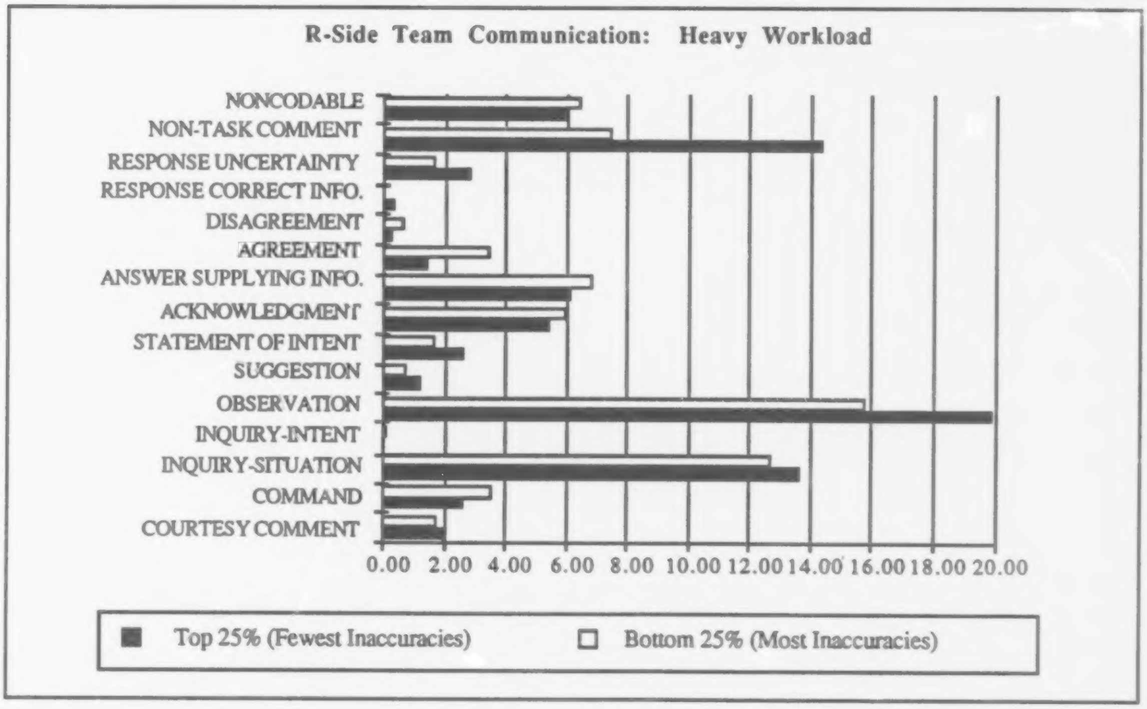
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	14.141	14.141	.141	.7088
WORKLOAD	1	43.308	43.308	.431	.5138
PERFORM-INAC ...	1	430.003	430.003	4.278	.0424
Residual	68	6835.078	100.516		

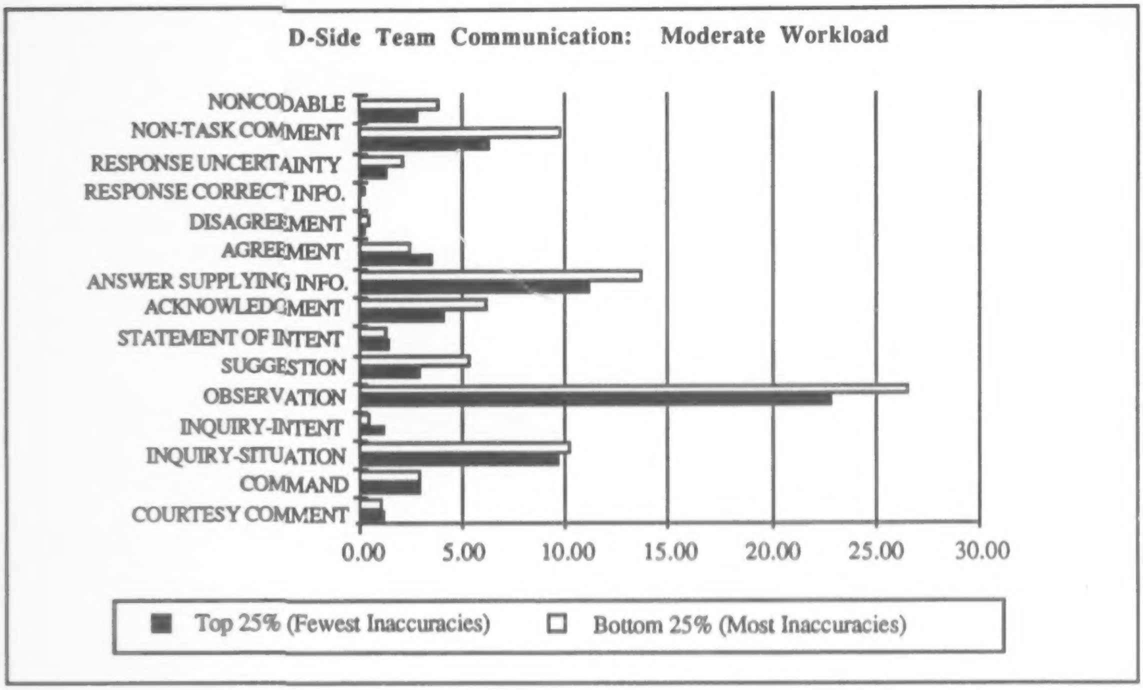
Dependent: TCR-NON-TASK

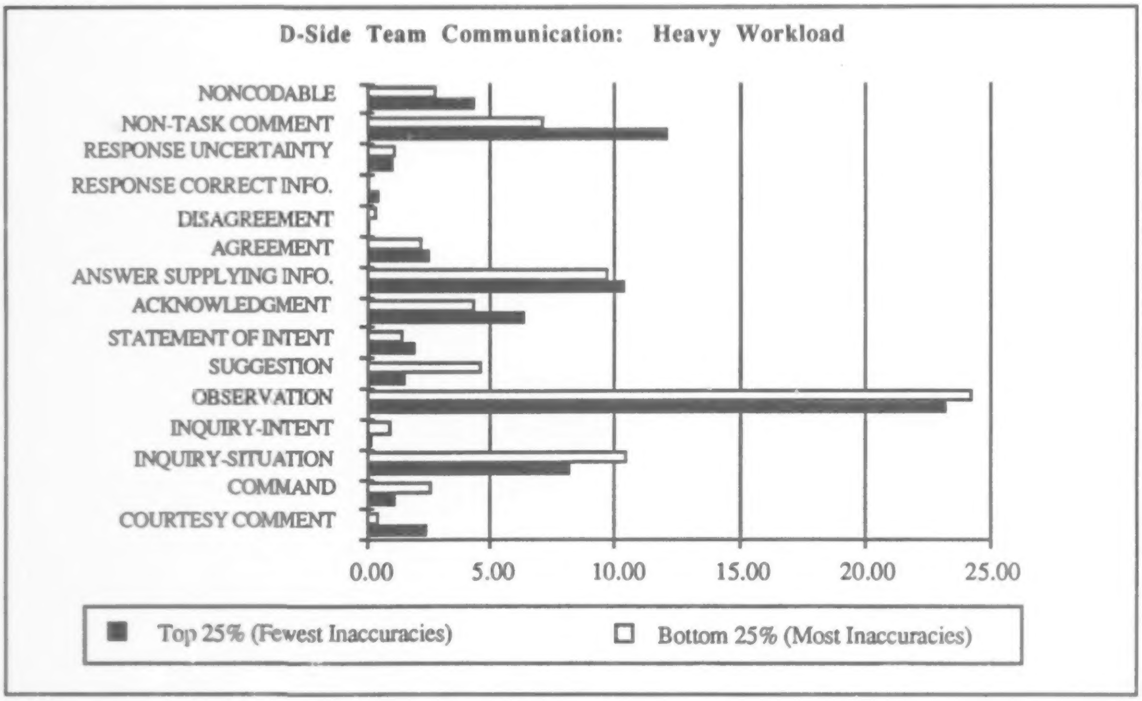
A-6.1 Charts of Team Communication Inaccuracy Performance





Charts of Team Communication Inaccuracy Performance





A-7.0 Additional ANOVA's - Nonroutine Communications

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	66.048	9.435	.549	.7936
WORKLOAD	1	2.693	2.693	.157	.6938
TEAM TYPE * W...	7	66.795	9.542	.555	.7888
Residual	56	962.730	17.192		

Dependent: COMBINED-NONR

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	56.066	8.009	.660	.7044
WORKLOAD	1	8.055	8.055	.664	.4186
TEAM TYPE * W...	7	20.137	2.877	.237	.9742
Residual	56	679.390	12.132		

Dependent: TEAM-NONR

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	6.146	.878	.704	.6684
WORKLOAD	1	.911	.911	.731	.3963
TEAM TYPE * W...	7	11.274	1.611	1.292	.2714
Residual	56	69.832	1.247		

Dependent: LINE-NONR

A-7.1 Additional ANOVA's – Communication Inaccuracy

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	235.253	33.608	4.381	.0002
SIDE	1	887.543	887.543	115.705	.0001
WORKLOAD	1	4.877	4.877	.636	.4269
TEAM TYPE * SIDE	7	154.253	22.036	2.873	.0085
TEAM TYPE * W...	7	46.462	6.637	.865	.5364
SIDE * WORKLOAD	1	31.641	31.641	4.125	.0446
TEAM TYPE * SI...	7	71.795	10.256	1.337	.2395
Residual	112	859.125	7.671		

Dependent: TOTAL INACC

Means Table
Effect: SIDE
Dependent: TOTAL INACC

	Count	Mean	Std. Dev.	Std. Error
R	72	6.722	4.240	.500
D	72	1.500	1.424	.168

Additional ANOVA's – Communication Inaccuracy

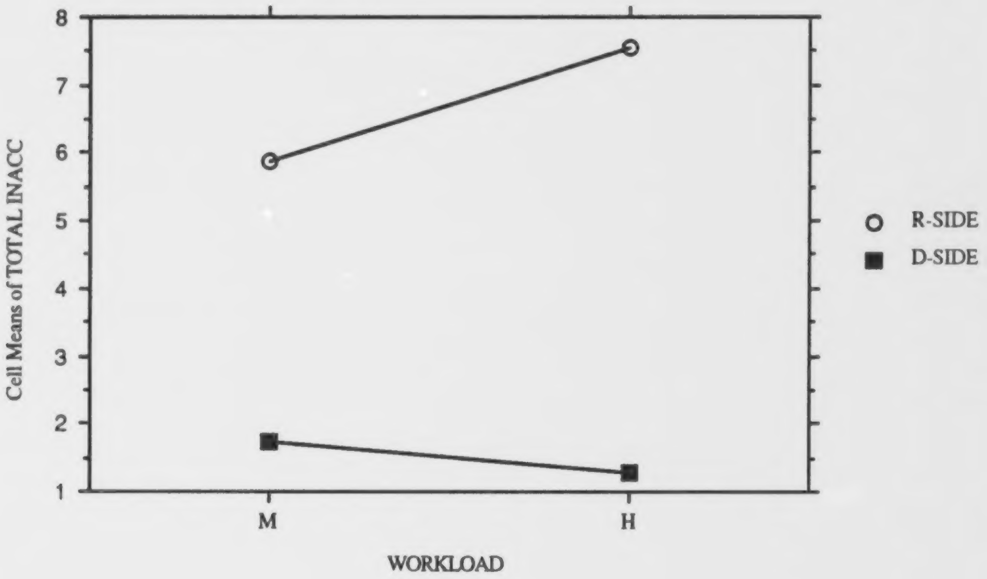
Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: TOTAL INACC
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EIN	EIE	.062	2.056	
	IIE	.562	2.166	
	EEE	1.188	2.239	
	NNE	2.344	2.291	S
	IIN	2.438	2.335	S
	NNN	3.000	2.364	S
	EEN	4.062	2.393	S
EIE	IIE	.500	2.056	
	EEE	1.125	2.166	
	NNE	2.281	2.239	S
	IIN	2.375	2.291	S
	NNN	2.938	2.335	S
	EEN	4.000	2.364	S
IIE	EEE	.625	2.056	
	NNE	1.781	2.166	
	IIN	1.875	2.239	
	NNN	2.438	2.291	S
	EEN	3.500	2.335	S
EEE	NNE	1.156	2.056	
	IIN	1.250	2.166	
	NNN	1.812	2.239	
	EEN	2.875	2.291	S
NNE	IIN	.094	2.056	
	NNN	.656	2.166	
	EEN	1.719	2.239	
IIN	NNN	.562	2.056	
	EEN	1.625	2.166	
NNN	EEN	1.062	2.056	

S = Significantly different at this level.

Additional ANOVA's – Communication Inaccuracy

Interaction Plot
Effect: SIDE * WORKLOAD
Dependent: TOTAL INACC



Means Table
Effect: SIDE * WORKLOAD
Dependent: TOTAL INACC

	Count	Mean	Std. Dev.	Std. Error
R-SIDE, M	36	5.889	4.097	.683
R-SIDE, H	36	7.556	4.272	.712
D-SIDE, M	36	1.722	1.799	.300
D-SIDE, H	36	1.278	.882	.147

A-8.0 Team Communication Correlations – Objective

Correlation Matrix for Variables: X_1 ... X_8

	SME-OVE	INACCUR	NONROUT	T-COURT	T-COMM	T-SITINQ	T-INTINQ	T-OBSER
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
T-COURT	-.09	-.12	.08	1				
T-COMM	-.37	.15	.30	.30	1			
T-SITINQ	-.18	.07	.48	.37	.43	1		
T-INTINQ	-.08	-.08	-.09	.14	.03	-.14	1	
T-OBSER	.23	-.01	.14	.14	.10	.53	.06	1

Correlation Matrix for Variables: X_1 ... X_8

	SME-OVE	INACCUR	NONROUT	T-SUGGE	T-STATE	T-ACKNO	T-ANSWE	T-AGREE
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
T-SUGGE	-.20	.30	.28	1				
T-STATE	.11	-.20	.21	.38	1			
T-ACKNO	-.07	1.02E-4	.2	.35	.47	1		
T-ANSWE	.01	.05	.42	.43	.29	.53	1	
T-AGREE	.21	.14	.06	.41	.19	.24	.36	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
T-COURT	Team Communication – Courtesy Comment
T-COMM	Team Communication – Command
T-SITINQ	Team Communication – Situational Inquiry
T-INTINQ	Team Communication – Inquiry - Intent
T-OBSER	Team Communication – Observation
T-SUGGE	Team Communication – Suggestion
T-STATE	Team Communication – Statement of Intent
T-ACKNO	Team Communication – Acknowledgment
T-ANSWE	Team Communication – Answer Supplying Information
T-AGREE	Team Communication – Agreement

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

Team Communication Correlations – Objective

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	T-DISAG	T-RCORR	T-RUNCE	T-NONTA	T-NONCO
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
T-DISAG	-.26	.36	.32	1				
T-RCORR	-.05	-.05	.15	-.14	1			
T-RUNCE	.09	-.05	.78	.16	-.08	1		
T-NONTA	.15	-.04	-.07	.04	-.07	.09	1	
T-NONCO	-.06	.13	.13	.36	-.05	.01	.37	1

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	TEAM EXP	R-EXPERI	D-EXPERI	R-FPL	D-FPL
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
TEAM EXP	.22	-.08	-.12	1				
R-EXPERI	.07	.05	-.07	.76	1			
D-EXPERI	.27	-.16	-.11	.76	.14	1		
R-FPL	.03	.07	-.09	.75	.99	.14	1	
D-FPL	.25	-.15	-.11	.75	.14	1	.14	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
T-DISAG	Team Communication – Disagreement
T-RCORR	Team Communication – Response Correcting Information
T-RUNCE	Team Communication – Response Uncertainty
T-NONTA	Team Communication – Non-Task-Related Comments
T-NONCO	Team Communication – Noncodable
TEAM EXP	Combined Controller Experience of Team Members
R-EXPERI	R-side Controller Experience
D-EXPERI	D-side Controller Experience
R-FPL	Number of Years R-side FPL Experience
D-FPL	Number of Years D-side FPL Experience

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

A-8.1 Team Communication Correlations –Subjective

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	S-AWAR	S-ASSER	S-ADAPT	S-TEAM	S-COMM
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
S-AWAR	.37	-.22	-.09	1				
S-ASSER	.21	-.11	-.09	.73	1			
S-ADAPT	.27	-.13	-.07	.78	.71	1		
S-TEAM	.32	-.05	-.15	.67	.76	.75	1	
S-COMM	.30	-.13	-.15	.81	.68	.80	.77	1

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	S-DECISI	S-DISCU	S-UNPRE	S-DETER	S-REALL
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
S-DECISI	.38	-.16	-.18	1				
S-DISCU	-.16	.23	.13	.05	1			
S-UNPRE	-.09	.09	-.05	-.01	.55	1		
S-DETER	-.09	.15	.09	.03	.59	.69	1	
S-REALL	-.14	.25	.11	.18	.52	.30	.32	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
S-AWAR	Subjective – Situational Awareness
S-ASSER	Subjective – Assertiveness
S-ADAPT	Subjective – Adaptability/Flexibility
S-TEAM	Subjective – Teamwork
S-COMM	Subjective – Communication
S-DECISI	Subjective – Decision Making
S-DISCU	Subjective – Discussion Necessary for Decisions
S-UNPRE	Subjective – Situations are Initially Unpredictable
S-DETER	Subjective – Tasks are Difficult to Determine in Advance
S-REALL	Subjective – Tasks Can be Reallocated

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

Team Communication Correlations – Subjective

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	S-COMPL	S-INPUT	S-REQUIR	S-BUSY	S-%DWOR
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
S-COMPL	-.26	.22	.11	1				
S-INPUT	-.20	.27	-.02	.48	1			
S-REQUIR	-.25	.31	.04	.71	.48	1		
S-BUSY	-.35	.37	.05	.34	.20	.34	1	
S-%DWOR	-.05	-.29	-.13	.05	-.20	.01	-.10	1

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	S-%RWOR	S-DISTRI	S-AMOU	S-COMM	S-ALLTE
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
S-%RWOR	-.04	.03	.08	1				
S-DISTRI	.08	.17	.15	.13	1			
S-AMOU	-.21	.17	-.05	.14	-.07	1		
S-COMM	-.09	-.09	.18	-4.45E-3	-.01	-.24	1	
S-ALLTE	.36	-.22	-.18	-.14	.06	.09	-.32	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
S-COMPL	Subjective - Task completion depends on other member
S-INPUT	Subjective - Tasks require input by both members
S-REQUIR	Subjective - Extensive decision making required
S-BUSY	Subjective - How busy was the sector
S-%DWOR	Subjective - Percent of workload by D-side
S-%RWOR	Subjective - Percent of workload by R-side
S-DISTRI	Subjective - Workload distribution
S-AMOU	Subjective - Amount of work to assure task completion
S-COMM	Subjective - Number of nonroutine communications
S-ALLTE	Subjective - Overall teamwork

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

Team Communication Correlations – Subjective

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	S-DYSIM	S-SINCE	SR-COMP	SD-COMP	S-CPILOTS
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
S-DYSIM	.06	3.46E-3	.01	1				
S-SINCE	.29	-.26	-.07	.02	1			
SR-COMP	-.04	-.05	.16	-.14	-.13	1		
SD-COMP	-.1	-.12	.24	-.13	-.05	.06	1	
S-CPILOTS	.12	-.02	-.18	.10	.27	-.56	-.03	1

Correlation Matrix for Variables: $X_1 \ldots X_6$

	SME-OV	INACCUR	NONROUT	S-CSECT	SR-DYSIM	SD-DYSIM
SME-OVE	1					
INACCUR	-.53	1				
NONROUT	-.21	.19	1			
S-CSECT	.17	-.02	-.07	1		
SR-DYSIM	.01	.07	.16	-.03	1	
SD-DYSIM	.12	-.01	-.01	-.04	-.05	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
S-DYSIM	Subjective – Team Communication DYSIM Feedback
S-SINCE	Subjective – Time since last worked together
SR-COMP	Subjective – Ground-Air Communication Inaccuracies
SD-COMP	Subjective – Ground-Line Communication Inaccuracies
S-CPILOTS	Subjective – Communication with pilots
S-CSECT	Subjective – Communication with other sectors
SR-DYSIM	Subjective – Frequency of Ground-Air Communications
SD-DYSIM	Subjective – Frequency of Ground-Line Communications

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

APPENDIX B: SIMULATED TRAFFIC: GROUND-AIR COMMUNICATION ANALYSES

B-1.0 Ground-Air Communication Coding Scheme and User Instructions

Command:	A specific assignment of responsibility in the form of a declarative statement.
Inquiry:	A request for factual information relating to the task; not a request for action.
Report:	Self initiated, the providing of task-related information.
Acknowledgment:	Verbally makes known that a prior speech turn was heard; does not supply additional information, or correct, or evaluate a previous speech turn.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment.
Response Correcting Presented Information:	A response that questions the accuracy of or corrects a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard and/or not understood.
Non-Task-Related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

B-1.1 User Instructions

Appendix B includes the following sections with the results of the Team Communication data analyses:

B-2.0 Summary of Team Communication Turn Frequencies by Team Type

> These turn frequencies represent the average number of occurrences and percentages for each communication category grouped by the eight team types. The data has been further subdivided by workload (MODERATE, HEAVY, and COMBINED).

B-3.0 ANOVA's: Team Communication for Team Type

> These ANOVA tables are reported in the same order as the communication types listed on the previous page (starting with Command and ending with Noncodable). If there are significant main effects, the means and/or Duncan New Multiple Range results are shown. And if there are significant interactions, they are represented graphically.

B-4.0 ANOVA's: Team Communication – SME Overall Team Operation

> These ANOVA tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in B-3.0.

B-5.0 ANOVA's: Team Nonroutine Communication Performance

> These ANOVA tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in B-3.0.

B-6.0 ANOVA's: Team Communication Inaccuracy Performance

> These ANOVA tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in B-3.0.

B-7.0 Team Communication Correlations – Objective

> The correlations with objective (communication categories) data are reported in this last section. The legend at the bottom of the page provides an explanation of the abbreviated variable names.

B-2.0 Summary of Ground-Air Turn Frequencies and Percentages by Team Type

EXPERT/EXPERT ESTABLISHED	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	40.3	64.0	52.2	56%	68%	63%
INQUIRY	7.8	4.8	6.3	11%	5%	8%
REPORT	7.9	9.4	8.6	11%	10%	10%
ACKNOWLEDGMENT	13.2	12.5	12.8	18%	13%	16%
ANSWER SUPPLYING INFO.	.8	1.4	1.1	1%	1%	1%
RESPONSE CORRECTING INFO.	.1	.3	.2	0%	0%	0%
RESPONSE UNCERTAINTY	1.6	1.0	1.3	2%	1%	2%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.0	.5	.3	0%	1%	0%
	72	94	83	100%	100%	100%

EXPERT/EXPERT NEW	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	58.0	51.3	54.6	69%	60%	64%
INQUIRY	5.0	8.0	6.5	6%	9%	8%
REPORT	10.8	6.0	8.4	13%	7%	10%
ACKNOWLEDGMENT	9.0	15.5	12.3	11%	18%	14%
ANSWER SUPPLYING INFO.	.5	1.3	.9	1%	1%	1%
RESPONSE CORRECTING INFO.	.0	.0	.0	0%	0%	0%
RESPONSE UNCERTAINTY	.8	2.0	1.4	1%	2%	2%
NON-TASK-RELATED COMMENT	.0	1.0	.5	0%	1%	1%
NONCODABLE	.5	.0	.3	1%	0%	0%
	85	85	85	100%	100%	100%

Summary of Ground-Air Turn Frequencies and Percentages by Team Type

EXPERT/INTERMEDIATE ESTABLISHED	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	49.7	68.6	59.2	61%	67%	65%
INQUIRY	7.5	5.5	6.5	9%	5%	7%
REPORT	9.1	10.0	9.6	11%	10%	10%
ACKNOWLEDGMENT	10.9	14.0	12.4	13%	14%	14%
ANSWER SUPPLYING INFO.	1.3	1.6	1.4	2%	2%	2%
RESPONSE CORRECTING INFO.	.4	.4	.4	0%	0%	0%
RESPONSE UNCERTAINTY	1.9	1.5	1.7	2%	1%	2%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.3	.4	.3	0%	0%	0%
	81	102	91	100%	100%	100%

EXPERT/INTERMEDIATE NEW	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	61.6	67.3	64.4	68%	65%	67%
INQUIRY	5.3	7.4	6.3	6%	7%	7%
REPORT	11.1	9.9	10.5	12%	10%	11%
ACKNOWLEDGMENT	10.0	14.3	12.1	11%	14%	13%
ANSWER SUPPLYING INFO.	.3	.8	.5	0%	1%	1%
RESPONSE CORRECTING INFO.	.0	.3	.1	0%	0%	0%
RESPONSE UNCERTAINTY	2.0	2.8	2.4	2%	3%	2%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.3	.8	.5	0%	1%	1%
	90	103	97	100%	100%	100%

Summary of Ground-Air Turn Frequencies and Percentages by Team Type

INTERMEDIATE/INT. ESTABLISHED	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	46.4	65.6	56.0	60%	66%	63%
INQUIRY	6.6	7.2	6.9	9%	7%	8%
REPORT	8.9	8.2	8.6	11%	8%	10%
ACKNOWLEDGMENT	12.5	16.5	14.5	16%	16%	16%
ANSWER SUPPLYING INFO.	.5	.6	.6	1%	1%	1%
RESPONSE CORRECTING INFO.	.5	.0	.3	1%	0%	0%
RESPONSE UNCERTAINTY	2.1	1.8	2.0	3%	2%	2%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.0	.0	.0	0%	0%	0%
	78	100	89	100%	100%	100%

INTERMEDIATE/INT. NEW	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	62.2	68.0	65.1	67%	65%	66%
INQUIRY	4.8	5.0	4.9	5%	5%	5%
REPORT	10.9	9.3	10.1	12%	9%	10%
ACKNOWLEDGMENT	11.5	17.8	14.6	12%	17%	15%
ANSWER SUPPLYING INFO.	.5	.0	.3	1%	0%	0%
RESPONSE CORRECTING INFO.	.5	1.0	.8	1%	1%	1%
RESPONSE UNCERTAINTY	2.7	3.0	2.8	3%	3%	3%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.0	.0	.0	0%	0%	0%
	93	104	98	100%	100%	100%

Summary of Ground-Air Turn Frequencies and Percentages by Team Type

NOVICE/NOVICE NEW	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	40.8	54.7	47.7	61%	67%	64%
INQUIRY	7.8	4.4	6.1	12%	5%	8%
REPORT	5.2	4.3	4.8	8%	5%	6%
ACKNOWLEDGMENT	10.3	13.0	11.6	15%	16%	16%
ANSWER SUPPLYING INFO.	.4	1.0	.7	1%	1%	1%
RESPONSE CORRECTING INFO.	.1	.5	.3	0%	1%	0%
RESPONSE UNCERTAINTY	2.4	3.6	3.0	4%	4%	4%
NON-TASK-RELATED COMMENT	.1	.0	.1	0%	0%	0%
NONCODABLE	.1	.4	.3	0%	0%	0%
	67	82	75	100%	100%	100%

NOVICE/NOVICE 2ND NEW	NO. OF TURNS			PERCENT		
	MOD	HEAVY	COMB	MOD	HEAVY	COMB
COMMAND	52.3	52.1	52.2	70%	64%	67%
INQUIRY	5.5	5.6	5.6	7%	7%	7%
REPORT	7.3	6.3	6.8	10%	8%	9%
ACKNOWLEDGMENT	7.0	14.8	10.9	9%	18%	14%
ANSWER SUPPLYING INFO.	.8	.0	.4	1%	0%	0%
RESPONSE CORRECTING INFO.	.0	.5	.3	0%	1%	0%
RESPONSE UNCERTAINTY	1.5	2.5	2.0	2%	3%	3%
NON-TASK-RELATED COMMENT	.0	.0	.0	0%	0%	0%
NONCODABLE	.0	.0	.0	0%	0%	0%
	74	82	78	100%	100%	100%

B-3.0 ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	4766.522	680.932	5.238	.0001
WORKLOAD	1	2697.213	2697.213	20.748	.0001
TEAM TYPE * W...	7	696.649	99.521	.766	.6184
Residual	56	7279.990	130.000		

Dependent: GROUND-AIR TASK

Means Table
Effect: WORKLOAD
Dependent: GROUND-AIR TASK

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	77.518	11.825	1.971
HEAVY	36	93.081	14.975	2.496

Means Table
Effect: TEAM TYPE
Dependent: GROUND-AIR TASK

	Count	Mean	Std. Dev.	Std. Error
EEE	8	82.495	15.354	5.429
EEN	4	84.000	8.524	4.262
EIE	16	91.187	16.067	4.017
EIN	8	96.337	11.166	3.948
IIE	8	88.721	12.757	4.510
IIN	4	98.500	10.755	5.377
NNE	16	74.258	15.833	3.958
NNN	8	78.000	8.246	2.915

ANOVA's: Ground-Air Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: GROUND-AIR TASK
Significance level: .05

	Vs.	Diff.	Crit. diff.	
NNE	NNN	3.742	12.126	
	EEE	8.236	12.767	
	EEN	9.742	13.186	
	IIE	14.463	13.434	S
	EIE	16.929	13.699	S
	EIN	22.079	13.879	S
	IIN	24.242	14.041	S
NNN	EEE	4.495	12.126	
	EEN	6.000	12.767	
	IIE	10.721	13.186	
	EIE	13.187	13.434	
	EIN	18.337	13.699	S
	IIN	20.500	13.879	S
EEE	EEN	1.505	12.126	
	IIE	6.226	12.767	
	EIE	8.693	13.186	
	EIN	13.843	13.434	S
	IIN	16.005	13.699	S
EEN	IIE	4.721	12.126	
	EIE	7.187	12.767	
	EIN	12.337	13.186	
	IIN	14.500	13.434	S
IIE	EIE	2.467	12.126	
	EIN	7.616	12.767	
	IIN	9.779	13.186	
EIE	EIN	5.150	12.126	
	IIN	7.312	12.767	
EIN	IIN	2.162	12.126	

S = Significantly different at this level.

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	2362.845	337.549	4.934	.0002
WORKLOAD	1	1429.910	1429.910	20.901	.0001
TEAM TYPE * W...	7	1336.790	190.970	2.791	.0145
Residual	56	3831.116	68.413		

Dependent: COMMAND

Means Table
Effect: TEAM TYPE
Dependent: COMMAND

	Count	Mean	Std. Dev.	Std. Error
EEE	8	52.172	14.473	5.117
EEN	4	54.625	6.019	3.010
EIE	16	59.177	13.188	3.297
EIN	8	64.417	8.514	3.010
IIE	8	55.985	11.433	4.042
IIN	4	65.083	3.632	1.816
NNE	16	47.743	12.386	3.096
NNN	8	52.188	3.337	1.180

ANOVA's: Ground-Air Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: COMMAND
Significance level: .05

	Vs.	Diff.	Crit. diff.	
NNE	EEE	4.430	8.796	
	NNN	4.445	9.262	
	EEN	6.882	9.566	
	IIE	8.242	9.746	
	EIE	11.434	9.938	S
	EIN	16.674	10.068	S
	IIN	17.340	10.186	S
EEE	NNN	.015	8.796	
	EEN	2.453	9.262	
	IIE	3.813	9.566	
	EIE	7.005	9.746	
	EIN	12.244	9.938	S
	IIN	12.911	10.068	S
NNN	EEN	2.438	8.796	
	IIE	3.798	9.262	
	EIE	6.990	9.566	
	EIN	12.229	9.746	S
	IIN	12.896	9.938	S
EEN	IIE	1.360	8.796	
	EIE	4.552	9.262	
	EIN	9.792	9.566	S
	IIN	10.458	9.746	S
IIE	EIE	3.192	8.796	
	EIN	8.431	9.262	
	IIN	9.098	9.566	
EIE	EIN	5.240	8.796	
	IIN	5.906	9.262	
EIN	IIN	.667	8.796	

S = Significantly different at this level.

ANOVA's: Ground-Air Communication for Team Type

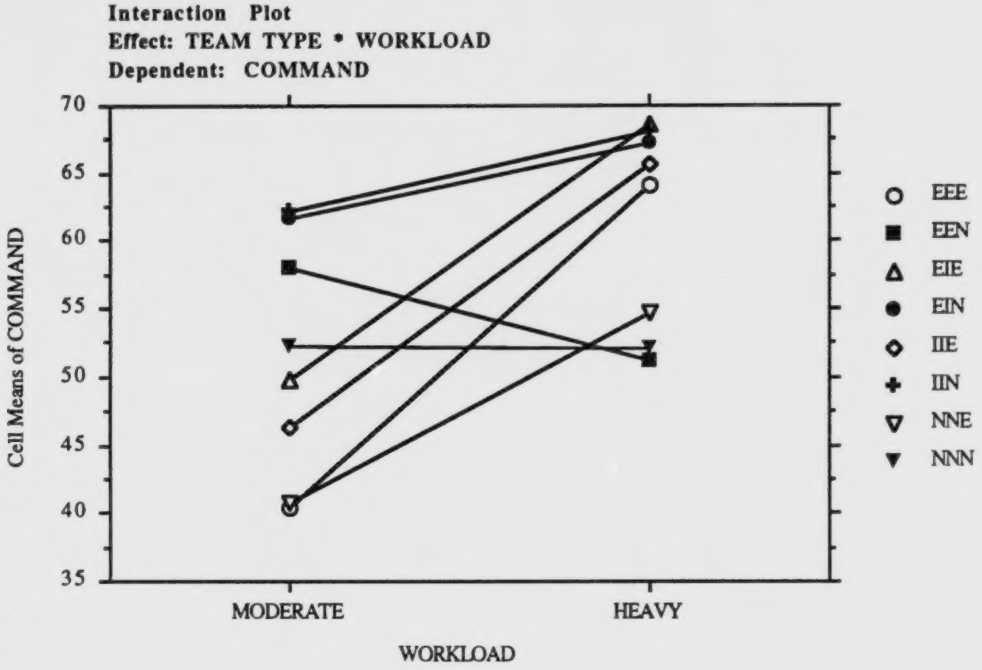
Means Table
Effect: WORKLOAD
Dependent: COMMAND

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	49.085	9.966	1.661
HEAVY	36	61.683	10.763	1.794

Means Table
Effect: TEAM TYPE * WORKLOAD
Dependent: COMMAND

	Count	Mean	Std. Dev.	Std. Error
EEE, MODERATE	4	40.345	10.112	5.056
EEE, HEAVY	4	64.000	3.674	1.837
EEN, MODERATE	2	58.000	2.828	2.000
EEN, HEAVY	2	51.250	7.425	5.250
EIE, MODERATE	8	49.729	6.676	2.360
EIE, HEAVY	8	68.625	11.141	3.939
EIN, MODERATE	4	61.583	11.268	5.634
EIN, HEAVY	4	67.250	4.555	2.278
IIE, MODERATE	4	46.375	3.987	1.993
IIE, HEAVY	4	65.595	6.542	3.271
IIN, MODERATE	2	62.167	2.357	1.666
IIN, HEAVY	2	68.000	0.000	0.000
NNE, MODERATE	8	40.833	6.920	2.446
NNE, HEAVY	8	54.653	13.104	4.633
NNN, MODERATE	4	52.250	3.227	1.614
NNN, HEAVY	4	52.125	3.945	1.972

ANOVA's Ground-Air Communication for Team Type



ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	16.638	2.377	.142	.9943
WORKLOAD	1	1.348	1.348	.081	.7772
TEAM TYPE * W...	7	80.364	11.481	.688	.6815
Residual	56	934.145	16.681		

Dependent: INQUIRY

Means Table
Effect: TEAM TYPE
Dependent: INQUIRY

	Count	Mean	Std. Dev.	Std. Error
EEE	8	6.291	4.503	1.592
EEN	4	6.500	2.121	1.061
EIE	16	6.521	4.187	1.047
EIN	8	6.312	3.047	1.077
IIE	8	6.903	2.846	1.006
IIN	4	4.875	2.780	1.390
NNE	16	6.073	5.197	1.299
NNN	8	5.562	3.076	1.087

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	291.619	41.660	3.890	.0016
WORKLOAD	1	13.527	13.527	1.263	.2659
TEAM TYPE * W...	7	37.269	5.324	.497	.8327
Residual	56	599.759	10.710		

Dependent: REPORT

Means Table
Effect: TEAM TYPE
Dependent: REPORT

	Count	Mean	Std. Dev.	Std. Error
EEE	8	8.637	1.631	.577
EEN	4	8.375	3.816	1.908
EIE	16	9.552	3.470	.868
EIN	8	10.504	3.840	1.358
IIE	8	8.562	2.287	.809
IIN	4	10.083	5.635	2.817
NNE	16	4.771	2.860	.715
NNN	8	6.750	2.420	.856

ANOVA's: Ground-Air Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE

Dependent: REPORT
Significance level: .05

	Vs.	Diff.	Crit. diff.	
NNE	NNN	1.979	3.480	
	EEN	3.604	3.664	
	IIE	3.791	3.785	S
	EEE	3.866	3.856	S
	EIE	4.781	3.932	S
	IIN	5.312	3.984	S
	EIN	5.733	4.030	S
NNN	EEN	1.625	3.480	
	IIE	1.812	3.664	
	EEE	1.887	3.785	
	EIE	2.802	3.856	
	IIN	3.333	3.932	
	EIN	3.754	3.984	
EEN	IIE	.187	3.480	
	EEE	.262	3.664	
	EIE	1.177	3.785	
	IIN	1.708	3.856	
	EIN	2.129	3.932	
IIE	EEE	.074	3.480	
	EIE	.990	3.664	
	IIN	1.521	3.785	
	EIN	1.942	3.856	
EEE	EIE	.915	3.480	
	IIN	1.446	3.664	
	EIN	1.867	3.785	
EIE	IIN	.531	3.480	
	EIN	.952	3.664	
IIN	EIN	.421	3.480	

S = Significantly different at this level.

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	84.693	12.099	.912	.5038
WORKLOAD	1	255.999	255.999	19.305	.0001
TEAM TYPE * W...	7	91.030	13.004	.981	.4545
Residual	56	742.605	13.261		

Dependent: ACKNOWLEDGMENT

Means Table
Effect: TEAM TYPE
Dependent: ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
EEE	8	12.841	2.972	1.051
EEN	4	12.250	5.909	2.955
EIE	16	12.438	3.366	.841
EIN	8	12.125	3.643	1.288
IIE	8	14.486	3.027	1.070
IIN	4	14.625	5.618	2.809
NNE	16	11.638	4.423	1.106
NNN	8	10.875	5.357	1.894

Means Table
Effect: WORKLOAD
Dependent: ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	10.576	3.357	.560
HEAVY	36	14.294	3.869	.645

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	11.170	1.596	1.378	.2329
WORKLOAD	1	.653	.653	.564	.4560
TEAM TYPE * W...	7	3.773	.539	.465	.8555
Residual	56	64.868	1.158		

Dependent: ANSWER SUPP INFO

Means Table
Effect: TEAM TYPE
Dependent: ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
EEE	8	1.087	.564	.199
EEN	4	.875	1.181	.591
EIE	16	1.438	1.548	.387
EIN	8	.500	.756	.267
IIE	8	.569	.495	.175
IIN	4	.250	.500	.250
NNE	16	.688	1.078	.270
NNN	8	.375	.744	.263

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	1.632	.233	.881	.5271
WORKLOAD	1	.347	.347	1.313	.2568
TEAM TYPE * W...	7	1.549	.221	.836	.5619
Residual	56	14.813	.265		

Dependent: RESP. CORRECTING

Means Table
Effect: TEAM TYPE
Dependent: RESP. CORRECTING

	Count	Mean	Std. Dev.	Std. Error
EEE	8	.188	.372	.132
EEN	4	0.000	0.000	0.000
EIE	16	.375	.619	.155
EIN	8	.125	.354	.125
IIE	8	.250	.463	.164
IIN	4	.750	.957	.479
NNE	16	.312	.479	.120
NNN	8	.250	.463	.164

Means Table
Effect: WORKLOAD
Dependent: RESP. CORRECTING

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	.208	.469	.078
HEAVY	36	.361	.543	.090

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	26.997	3.857	1.307	.2640
WORKLOAD	1	2.442	2.442	.828	.3669
TEAM TYPE * W...	7	9.520	1.360	.461	.8585
Residual	56	165.217	2.950		

Dependent: RESP. UNCERTAINTY

Means Table
Effect: TEAM TYPE
Dependent: RESP. UNCERTAINTY

	Count	Mean	Std. Dev.	Std. Error
EEE	8	1.279	1.001	.354
EEN	4	1.375	1.797	.898
EIE	16	1.688	1.138	.285
EIN	8	2.354	2.237	.791
IIE	8	1.965	1.703	.602
IIN	4	2.833	1.599	.799
NNE	16	3.033	2.002	.500
NNN	8	2.000	1.604	.567

ANOVA's: Ground-Air Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	.938	.134	2.609	.0210
WORKLOAD	1	.170	.170	3.314	.0740
TEAM TYPE * W...	7	1.049	.150	2.918	.0113
Residual	56	2.875	.051		

Dependent: NON-TASK

Means Table
Effect: WORKLOAD
Dependent: NON-TASK

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	.028	.167	.028
HEAVY	36	.056	.333	.056

Means Table
Effect: TEAM TYPE
Dependent: NON-TASK

	Count	Mean	Std. Dev.	Std. Error
EEE	8	0.000	0.000	0.000
EEN	4	.500	1.000	.500
EIE	16	0.000	0.000	0.000
EIN	8	0.000	0.000	0.000
IIE	8	0.000	0.000	0.000
IIN	4	0.000	0.000	0.000
NNE	16	.062	.250	.062
NNN	8	0.000	0.000	0.000

ANOVA's: Ground-Air Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: NON-TASK
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EEE	NNN	0.000	.241	
	EIE	0.000	.254	
	EIN	0.000	.262	
	IIE	0.000	.267	
	IIN	0.000	.272	
	NNE	.062	.276	
	EEN	.500	.279	S
NNN	EIE	0.000	.241	
	EIN	0.000	.254	
	IIE	0.000	.262	
	IIN	0.000	.267	
	NNE	.062	.272	
	EEN	.500	.276	S
EIE	EIN	0.000	.241	
	IIE	0.000	.254	
	IIN	0.000	.262	
	NNE	.062	.267	
	EEN	.500	.272	S
EIN	IIE	0.000	.241	
	IIN	0.000	.254	
	NNE	.062	.262	
	EEN	.500	.267	S
IIE	IIN	0.000	.241	
	NNE	.062	.254	
	EEN	.500	.262	S
IIN	NNE	.062	.241	
	EEN	.500	.254	S
NNE	EEN	.438	.241	S

S = Significantly different at this level.

ANOVA's: Ground-Air Communication for Team Type

Means Table
Effect: TEAM TYPE * WORKLOAD
Dependent: NON-TASK

	Count	Mean	Std. Dev.	Std. Error
EEE, MODERATE	4	0.000	0.000	0.000
EEE, HEAVY	4	0.000	0.000	0.000
EEN, MODERATE	2	0.000	0.000	0.000
EEN, HEAVY	2	1.000	1.414	1.000
EIE, MODERATE	8	0.000	0.000	0.000
EIE, HEAVY	8	0.000	0.000	0.000
EIN, MODERATE	4	0.000	0.000	0.000
EIN, HEAVY	4	0.000	0.000	0.000
IIE, MODERATE	4	0.000	0.000	0.000
IIE, HEAVY	4	0.000	0.000	0.000
IIN, MODERATE	2	0.000	0.000	0.000
IIN, HEAVY	2	0.000	0.000	0.000
NNE, MODERATE	8	.125	.354	.125
NNE, HEAVY	8	0.000	0.000	0.000
NNN, MODERATE	4	0.000	0.000	0.000
NNN, HEAVY	4	0.000	0.000	0.000

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	1.757	.251	.735	.6432
WORKLOAD	1	.170	.170	.498	.4832
TEAM TYPE * W...	7	1.062	.152	.444	.8698
Residual	56	19.125	.342		

Dependent: NONCODABLE

B-4.0 ANOVA's: Ground-Air SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	12.636	12.636	.107	.7454
WORKLOAD	1	496.123	496.123	4.213	.0484
PERFORM-SME ...	1	80.526	80.526	.684	.4144
Residual	32	3768.317	117.760		

Dependent: GA-COMMAND

Means Table
Effect: WORKLOAD
Dependent: GA-COMMAND

	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	56.647	9.648	2.340
MODERATE	19	49.333	11.471	2.632

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	3.202	3.202	.204	.6549
WORKLOAD	1	3.683	3.683	.234	.6317
PERFORM-SME ...	1	1.831	1.831	.116	.7352
Residual	32	503.276	15.727		

Dependent: GA-INQUIRY

ANOVA's: Ground-Air SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	90.488	90.488	5.423	.0263
WORKLOAD	1	3.924	3.924	.235	.6310
PERFORM-SME ...	1	14.733	14.733	.883	.3544
Residual	32	533.943	16.686		

Dependent: GA-REPORT

Means Table
Effect: PERFORM-SME
Dependent: GA-REPORT

	Count	Mean	Std. Dev.	Std. Error
TOP	18	9.187	3.560	.839
BOTTOM	18	5.926	4.455	1.050

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.561	.561	.037	.8496
WORKLOAD	1	232.550	232.550	15.146	.0005
PERFORM-SME ...	1	9.807	9.807	.639	.4301
Residual	32	491.340	15.354		

Dependent: GA-ACKNOWLEDGMENT

Means Table
Effect: WORKLOAD
Dependent: GA-ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	15.059	4.069	.987
MODERATE	19	9.842	3.625	.832

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.562	.562	.646	.4276
WORKLOAD	1	.879	.879	1.010	.3225
PERFORM-SME ...	1	.120	.120	.138	.7124
Residual	32	27.860	.871		

Dependent: GA-ANSWER SUPP INFO

ANOVA's: Ground-Air SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.222	.222	.775	.3853
WORKLOAD	1	.717	.717	2.503	.1234
PERFORM-SME ...	1	.001	.001	.004	.9483
Residual	32	9.171	.287		

Dependent: GA-RESP. CORRECTING

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	15.016	15.016	4.347	.0451
WORKLOAD	1	8.769	8.769	2.539	.1209
PERFORM-SME ...	1	3.466	3.466	1.003	.3240
Residual	32	110.537	3.454		

Dependent: GA-RESP. UNCERTAINTY

Means Table
Effect: PERFORM-SME
Dependent: GA-RESP. UNCERTAINTY

	Count	Mean	Std. Dev.	Std. Error
TOP	18	1.630	1.804	.425
BOTTOM	18	3.074	1.995	.470

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.309	.309	2.281	.1408
WORKLOAD	1	.083	.083	.610	.4404
PERFORM-SME ...	1	.083	.083	.610	.4404
Residual	32	4.338	.136		

Dependent: GA-NON-TASK

ANOVA's: Ground-Air SME Overall Team Operation

Type III Sums of Squares

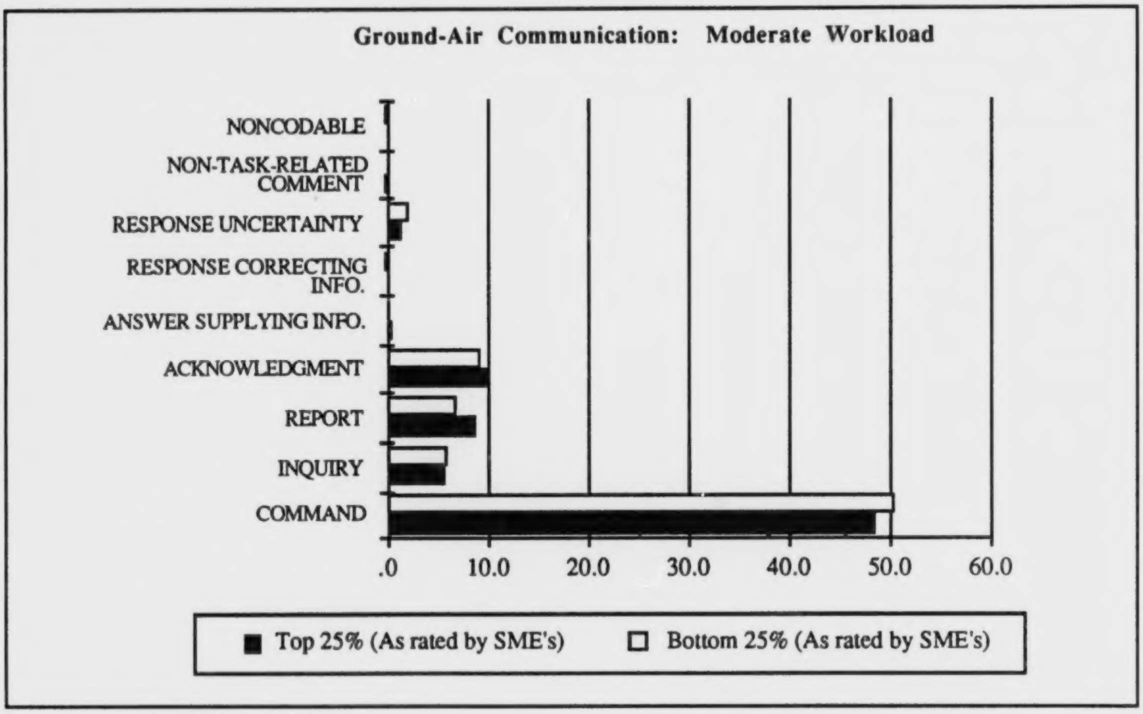
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.006	.006	.015	.9024
WORKLOAD	1	1.952	1.952	4.773	.0363
PERFORM-SME ...	1	.084	.084	.206	.6533
Residual	32	13.089	.409		

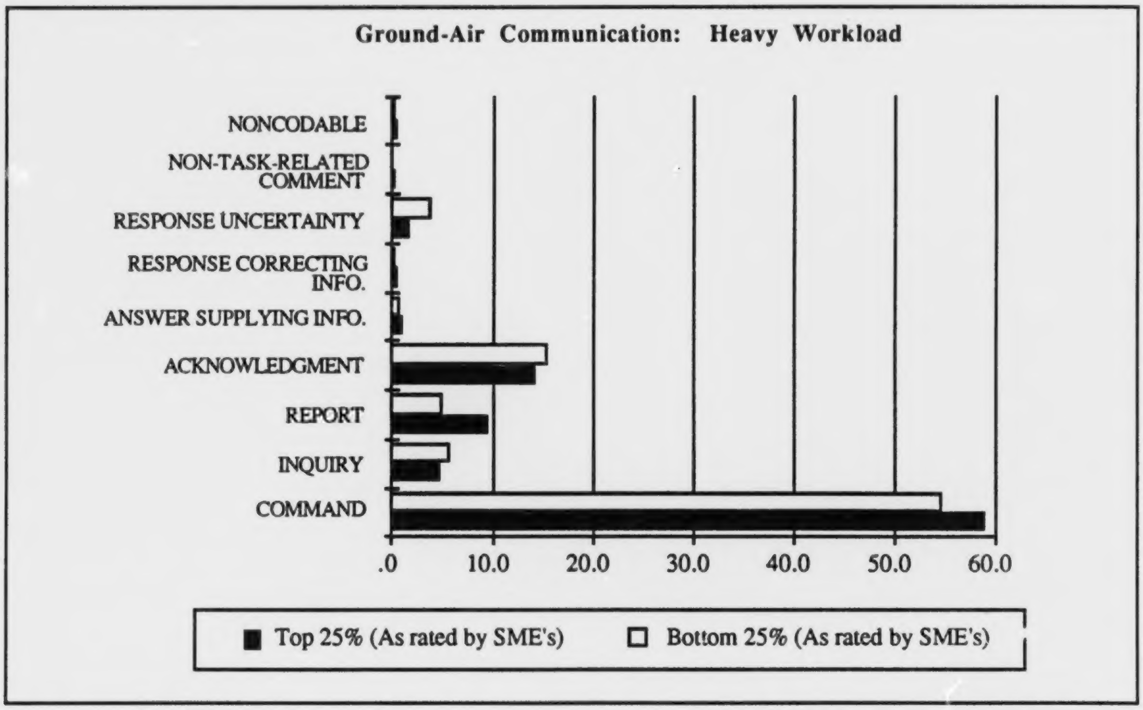
Dependent: GA-NONCODABLE

Means Table
Effect: WORKLOAD
Dependent: GA-NONCODABLE

	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	.529	.874	.212
MODERATE	19	.053	.229	.053

B-4.1 Charts of the SME Overall Team Operation Ratings


Ground-Air Communication: Moderate Workload


Ground-Air Communication: Heavy Workload

B-5.0 ANOVA's: Ground-Air Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	25.848	25.848	.214	.6468
WORKLOAD	1	1758.613	1758.613	14.557	.0006
PERFORM-NONR ...	1	114.489	114.489	.948	.3376
Residual	32	3866.011	120.813		

Dependent: GA-COMMAND

Means Table
Effect: WORKLOAD
Dependent: GA-COMMAND

	Count	Mean	Std. Dev.	Std. Error
MODERATE	19	47.789	9.205	2.112
HEAVY	17	61.706	12.439	3.017

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	25.052	25.052	1.370	.2504
WORKLOAD	1	8.820	8.820	.482	.4924
PERFORM-NONR ...	1	6.957	6.957	.380	.5417
Residual	32	585.097	18.284		

Dependent: GA-INQUIRY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.216	.216	.014	.9053
WORKLOAD	1	6.891	6.891	.458	.5035
PERFORM-NONR ...	1	.929	.929	.062	.8054
Residual	32	481.656	15.052		

Dependent: GA-REPORT

ANOVA's: Ground-Air Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	28.224	28.224	2.368	.1336
WORKLOAD	1	152.087	152.087	12.763	.0011
PERFORM-NONR ...	1	10.795	10.795	.905	.3483
Residual	32	381.331	11.917		

Dependent: GA-ACKNOWLEDGMENT

Means Table
Effect: WORKLOAD
Dependent: GA-ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	19	10.421	3.564	.818
HEAVY	17	14.647	3.445	.836

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	8.575	8.575	9.467	.0043
WORKLOAD	1	.073	.073	.080	.7785
PERFORM-NONR ...	1	2.557	2.557	2.823	.1026
Residual	32	28.986	.906		

Dependent: GA-ANSWER SUPP INFO

Means Table
Effect: PERFORM-NONR
Dependent: GA-ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
TOP	18	1.278	1.227	.289
BOTTOM	18	.333	.594	.140

ANOVA's: Ground-Air Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.388	.388	2.354	.1348
WORKLOAD	1	.499	.499	3.023	.0917
PERFORM-NONR ...	1	.002	.002	.010	.9192
Residual	32	5.278	.165		

Dependent: GA-RESP. CORRECTING

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	39.079	39.079	13.778	.0008
WORKLOAD	1	2.971	2.971	1.048	.3137
PERFORM-NONR ...	1	.363	.363	.128	.7230
Residual	32	90.764	2.836		

Dependent: GA-RESP. UNCERTAINTY

Means Table
Effect: PERFORM-NONR
Dependent: GA-RESP. UNCERTAINTY

	Count	Mean	Std. Dev.	Std. Error
TOP	18	1.167	.985	.232
BOTTOM	18	3.278	2.137	.504

ANOVA's: Ground-Air Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.140	.140	1.278	.2667
WORKLOAD	1	.140	.140	1.278	.2667
PERFORM-NONR ...	1	.140	.140	1.278	.2667
Residual	32	3.500	.109		

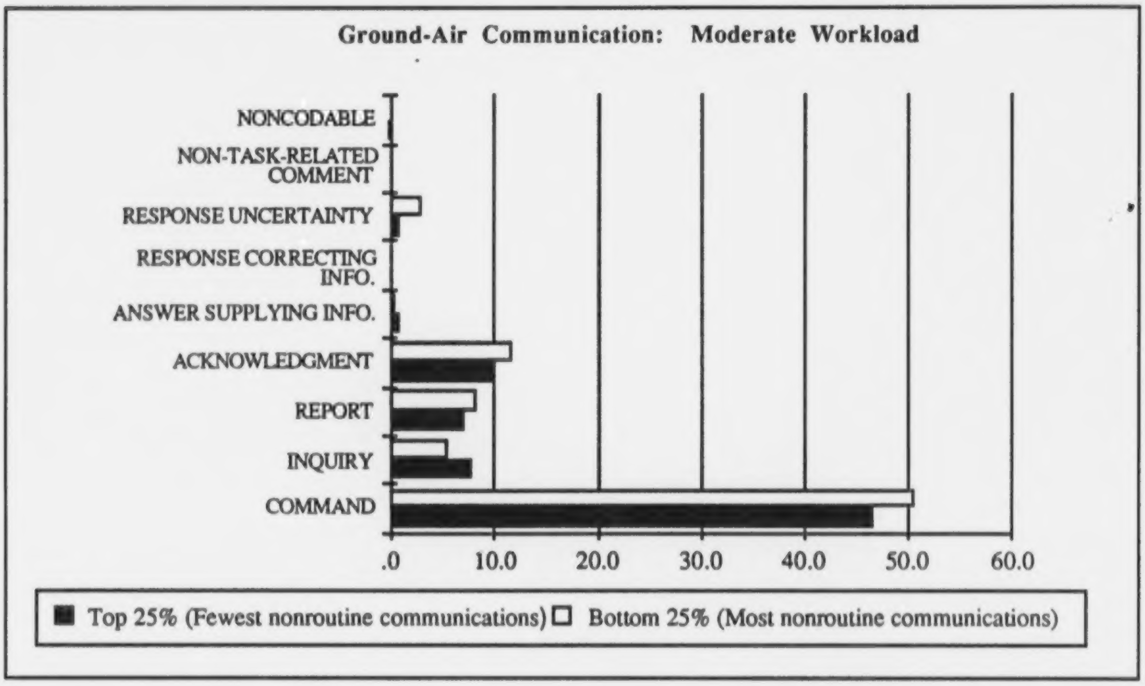
Dependent: GA-NON-TASK

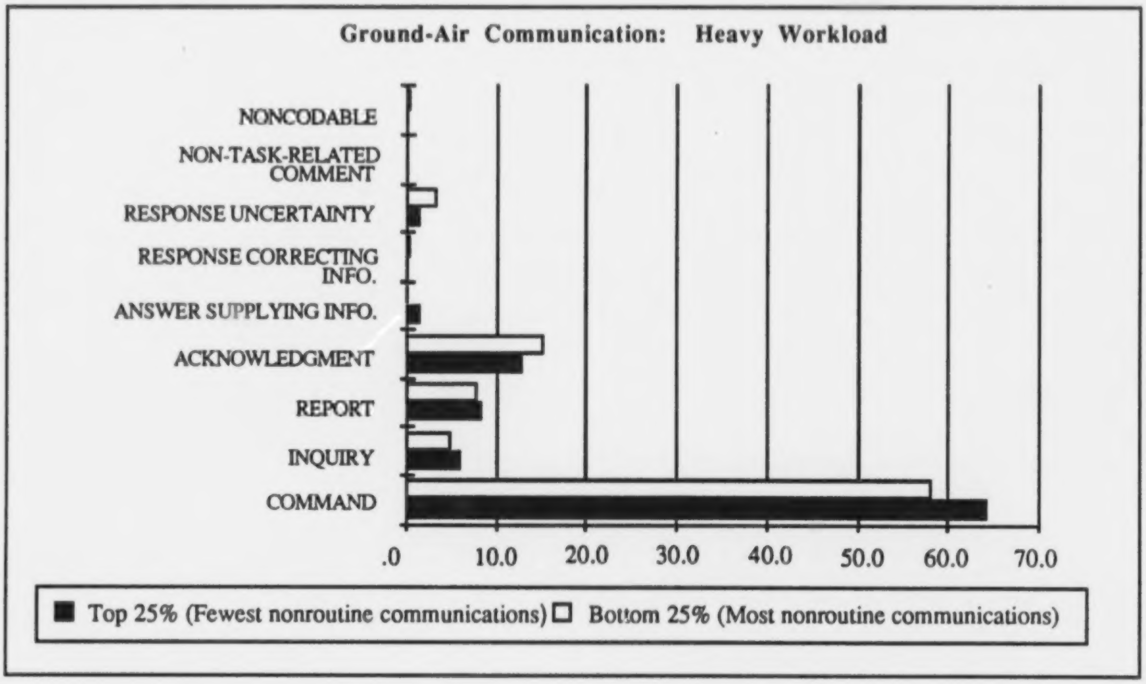
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.265	.265	.931	.3419
WORKLOAD	1	.265	.265	.931	.3419
PERFORM-NONR ...	1	.663	.663	2.325	.1371
Residual	32	9.122	.285		

Dependent: GA-NONCODABLE

B-5.1 Charts of Ground-Air Nonroutine Communication Performance





B-6.0 ANOVA's: Ground-Air Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	421.559	421.559	7.747	.0090
WORKLOAD	1	828.003	828.003	15.217	.0005
PERFORM-INAC ...	1	618.139	618.139	11.360	.0020
Residual	32	1741.247	54.414		

Dependent: GA-COMMAND

Means Table
Effect: PERFORM-INAC
Dependent: GA-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP	18	57.222	10.957	2.583
BOTTOM	18	52.389	8.211	1.935

Means Table
Effect: WORKLOAD
Dependent: GA-COMMAND

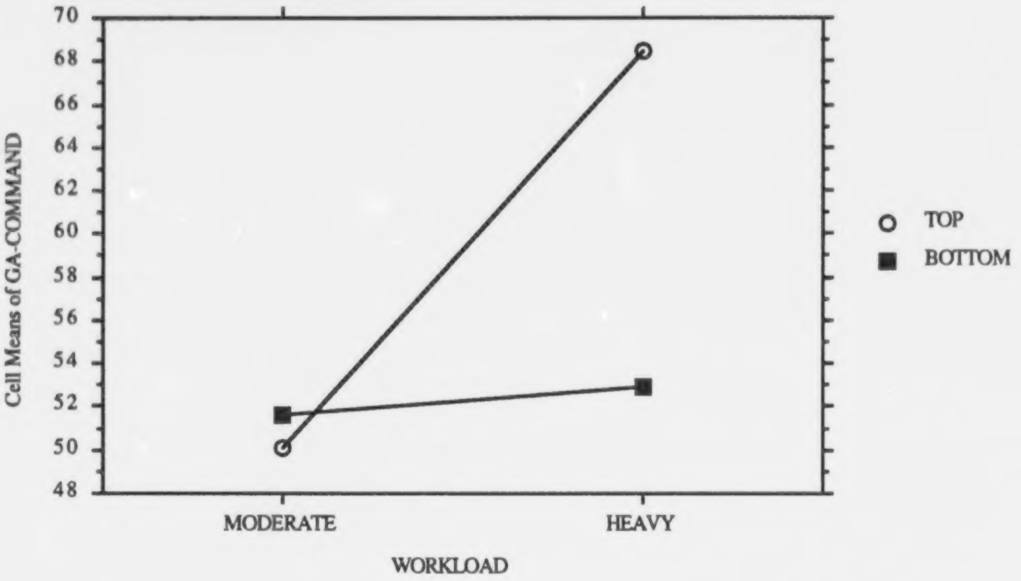
	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	50.667	6.297	1.484
HEAVY	18	58.944	11.133	2.624

Means Table
Effect: PERFORM-INAC • WORKLOAD
Dependent: GA-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	11	50.091	6.363	1.919
TOP, HEAVY	7	68.429	5.740	2.170
BOTTOM, MODERATE	7	51.571	6.579	2.487
BOTTOM, HEAVY	11	52.909	9.375	2.827

ANOVA's: Ground-Air Communication Inaccuracy Performance

Interaction Plot
Effect: PERFORM-INAC * WORKLOAD
Dependent: GA-COMMAND



Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	2.453	2.453	.178	.6771
PROBLEM	5	33.635	6.727	.487	.7824
PERFORM-INAC ...	5	27.125	5.425	.393	.8487
Residual	24	331.367	13.807		

Dependent: GA-INQUIRY

ANOVA's: Ground-Air Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	86.970	86.970	11.498	.0019
WORKLOAD	1	30.970	30.970	4.094	.0514
PERFORM-INAC ...	1	1.922	1.922	.254	.6176
Residual	32	242.052	7.564		

Dependent: GA-REPORT

Means Table
Effect: PERFORM-INAC
Dependent: GA-REPORT

	Count	Mean	Std. Dev.	Std. Error
TOP	18	9.444	2.770	.653
BOTTOM	18	5.833	2.915	.687

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	18.101	18.101	1.068	.3092
WORKLOAD	1	102.101	102.101	6.023	.0197
PERFORM-INAC ...	1	.902	.902	.053	.8190
Residual	32	542.442	16.951		

Dependent: GA-ACKNOWLEDGMENT

Means Table
Effect: WORKLOAD
Dependent: GA-ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	10.167	3.400	.801
HEAVY	18	13.944	4.633	1.092

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.104	.104	.142	.7089
WORKLOAD	1	.549	.549	.747	.3939
PERFORM-INAC ...	1	3.608E-4	3.608E-4	4.91E-4	.9825
Residual	32	23.506	.735		

Dependent: GA-ANSWER SUPP INFO

ANOVA's: Ground-Air Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.061	.061	.222	.6406
WORKLOAD	1	1.172	1.172	4.272	.0469
PERFORM-INAC ...	1	.104	.104	.380	.5420
Residual	32	8.779	.274		

Dependent: GA-RESP. CORRECTING

Means Table
Effect: WORKLOAD
Dependent: GA-RESP. CORRECTING

	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	.167	.383	.090
HEAVY	18	.556	.616	.145

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	2.668	2.668	.798	.3782
WORKLOAD	1	.001	.001	4.32E-4	.9836
PERFORM-INAC ...	1	.175	.175	.052	.8206
Residual	32	106.935	3.342		

Dependent: GA-RESP. UNCERTAINTY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.071	.071	.622	.4360
WORKLOAD	1	.071	.071	.622	.4360
PERFORM-INAC ...	1	.071	.071	.622	.4360
Residual	32	3.636	.114		

Dependent: GA-NON-TASK

ANOVA's: Ground-Air Communication Inaccuracy Performance

Type III Sums of Squares

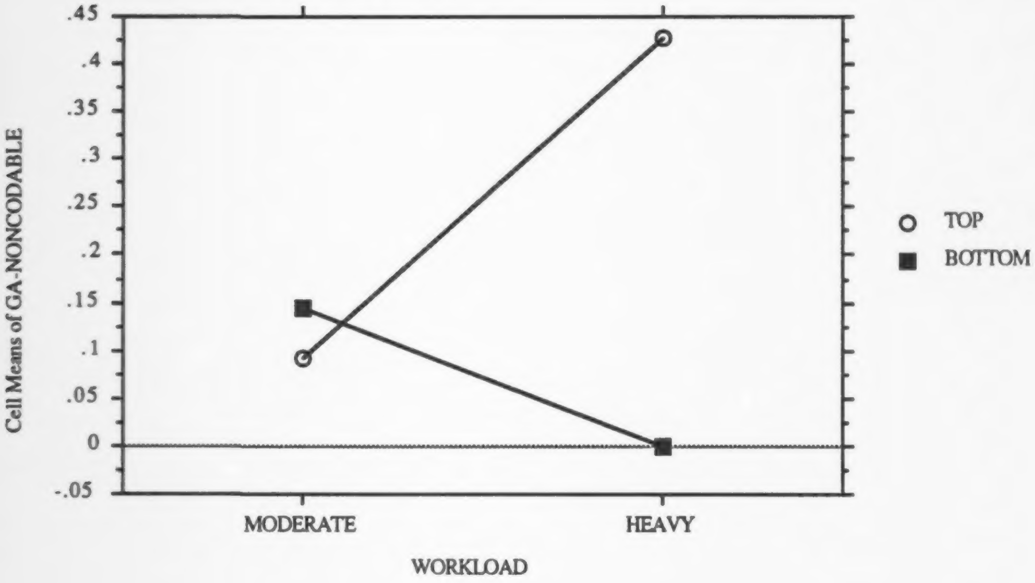
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.303	.303	2.789	.1046
WORKLOAD	1	.081	.081	.746	.3941
PERFORM-INAC ...	1	.494	.494	4.541	.0409
Residual	32	3.481	.109		

Dependent: GA-NONCODABLE

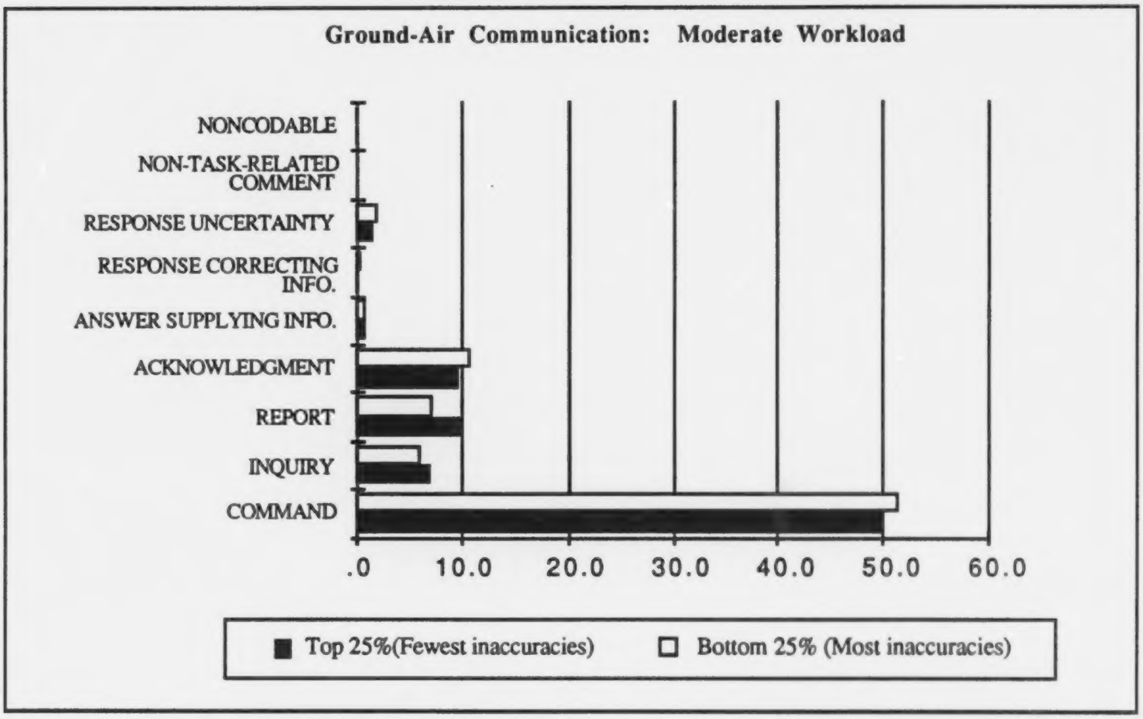
Means Table
Effect: PERFORM-INAC * WORKLOAD
Dependent: GA-NONCODABLE

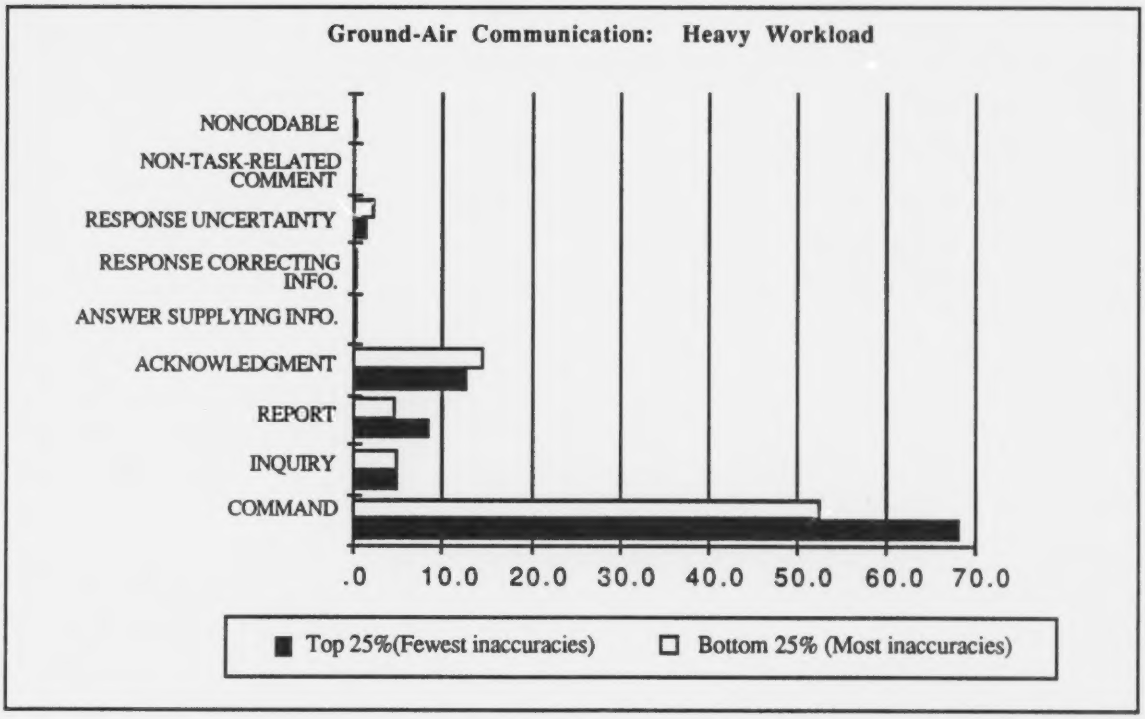
	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	11	.091	.302	.091
TOP, HEAVY	7	.429	.535	.202
BOTTOM, MODERATE	7	.143	.378	.143
BOTTOM, HEAVY	11	0.000	0.000	0.000

Interaction Plot
Effect: PERFORM-INAC * WORKLOAD
Dependent: GA-NONCODABLE



B-6.1 Charts for Ground-Air Communication Inaccuracy Performance





B-7.0 Ground-Air Correlations-Objective

Correlation Matrix for Variables: $X_1 \ldots X_8$

	SME-OVE	INACCUR	NONROUT	A-COMM	A-INQUIRY	A-REPORT	A-ACKNO	A-ANSW
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
A-COMM	3.57E-3	-.07	-.12	1				
A-INQUIRY	.06	-.1	-.11	-.03	1			
A-REPORT	.39	-.41	.08	.24	2.29E-3	1		
A-ACKNO	-.16	.17	.14	.2	-.02	-.13	1	
A-ANSW	.08	-.04	-.2	.25	.13	-.04	.08	1

Correlation Matrix for Variables: $X_1 \ldots X_7$

	SME-OVE	INACCUR	NONROUT	A-RESPC	A-RESPU	A-NON-T	A-NON-C
SME-OVE	1						
INACCUR	-.53	1					
NONROUT	-.21	.19	1				
A-RESPC	.04	.15	.13	1			
A-RESPU	-.28	.09	.49	.15	1		
A-NON-T	.17	.05	-.08	-.09	-.11	1	
A-NON-C	.01	-.12	.07	.02	.02	-.06	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
A-COMM	Ground-Air – Command
A-INQUIRY	Ground-Air – Inquiry
A-REPORT	Ground-Air – Report
A-ACKNO	Ground-Air – Acknowledgment
A-ANSW	Ground-Air – Answer Supplying Information
A-RESPC	Ground-Air – Response Correcting Information
A-RESPU	Ground-Air – Response Uncertainty
A-NON-T	Ground-Air – Non-Task -Related Comment
A-NON-C	Ground-Air – Noncodable

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

APPENDIX C: SIMULATED TRAFFIC: GROUND-LINE COMMUNICATION ANALYSES

C-1.0 Ground-Line Communication Coding Scheme and User Instructions

Command:	A specific assignment of responsibility in the form of a declarative statement or a request for action that is not a handoff or a pointout.
Verbal Handoff:	A verbal request to transfer radar identification and radio communication to another sector while maintaining radio contact.
Pointout:	A verbal request to transfer radar identification to another sector while maintaining radio contact.
Inquiry:	A request for factual information relating to the task; not a request for action.
Report:	Self initiated, the providing of task-related information.
Request Permission:	A speech turn asking permission to take an action one's self.
Acknowledgment:	Verbally makes known that a prior speech turn was heard; does not supply additional information, or correct, or evaluate a previous speech turn.
Answer Supplying Information:	A speech turn supplying information beyond mere acknowledgment.
Response Correcting Presented Information:	A response that questions the accuracy of or corrects a prior speech turn.
Response Uncertainty:	A response indicating that a previous speech turn was not heard and/or not understood.
Non-Task-related Comment:	Any speech turn referring to something other than a task.
Noncodable:	Any speech turn that is unintelligible or unclassified with the current coding scheme.

C-1.1 User Instructions

Appendix C includes the following sections with the results of the Team Communication data analyses:

C-2.0 Summary of Team Communication Turn Frequencies by Team Type

These turn frequencies represent the average number of occurrences for each communication category grouped by the eight team types. The data has been further subdivided by workload (MODERATE, HEAVY, and COMBINED) and side (R-SIDE, D-SIDE, and TOTAL).

C-3.0 ANOVA's: Team Communication for Team Type

These ANOVA Tables are reported in the same order as the communication types are listed on the previous page (starting with Command and ending with Noncodable). If there are significant main effects, the means and/or Duncan New Multiple Range results are shown. And if there are significant interactions, they are represented graphically.

C-4.0 ANOVA's: Team Communication – SME Overall Team Operation

These ANOVA Tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in C-3.0.

C-5.0 ANOVA's: Team Nonroutine Communication Performance

These ANOVA Tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in C-3.0.

C-6.0 ANOVA's: Team Communication Inaccuracy Performance

These ANOVA Tables are reported in the same order as the communication types listing, and the effects are reported in the same way as with the Team Type ANOVA's in C-3.0.

C-7.0 Team Communication Correlations-Objective

The correlations with objective (communication categories) data are reported in this section. The legends at the bottom of each page provide an explanation of the abbreviated variable names.

C-2.0 Summary of Ground-Line Turn Frequencies and Percentages by Team Type

EXPERT/EXPERT ESTABLISHED	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.1	6.4	6.5	.0	5.3	5.3	.1	5.8	5.9
VERBAL HANDOFF	.0	.0	.0	.0	.0	.0	.0	.0	.0
POINTOUT	.1	.6	.7	.0	.5	.5	.1	.5	.6
INQUIRY	.3	2.9	3.2	.0	3.0	3.0	.1	3.0	3.1
REPORT	.0	1.1	1.1	.0	.5	.5	.0	.8	.8
REQUEST PERMISSION	.0	1.3	1.3	.0	1.0	1.0	.0	1.2	1.2
ACKNOWLEDGMENT	.0	13.2	13.2	.0	14.8	14.8	.0	14.0	14.0
ANSWER SUPPLYING INFO.	.0	1.5	1.5	.0	4.5	4.5	.0	3.0	3.0
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	.0	1.9	1.9	.0	.8	.8	.0	1.3	1.3
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	1.2	1.2	.0	.5	.5	.0	.8	.8
	1	30	31	0	31	31	0	30	31

EXPERT/EXPERT NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	5.3	5.3	.0	7.0	7.0	.0	6.1	6.1
VERBAL HANDOFF	.0	.5	.5	.0	.5	.5	.0	.5	.5
POINTOUT	.0	.5	.5	.0	.0	.0	.0	.3	.3
INQUIRY	.0	1.8	1.8	.0	2.0	2.0	.0	1.9	1.9
REPORT	.0	1.0	1.0	.0	1.0	1.0	.0	1.0	1.0
REQUEST PERMISSION	.0	.5	.5	.0	.5	.5	.0	.5	.5
ACKNOWLEDGMENT	.0	16.5	16.5	.0	11.5	11.5	.0	14.0	14.0
ANSWER SUPPLYING INFO.	.0	2.5	2.5	.0	2.0	2.0	.0	2.3	2.3
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	.0	2.5	2.5	.0	.5	.5	.0	1.5	1.5
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	1.5	1.5	.0	1.0	1.0	.0	1.3	1.3
	0	33	33	0	26	26	0	29	29

Summary of Ground-Line Turn Frequencies and Percentages by Team Type

EXPERT/INTERMEDIATE EST.	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	4.9	4.9	.0	7.4	7.4	.0	6.2	6.2
VERBAL HANDOFF	.0	.1	.1	.0	.3	.3	.0	.2	.2
POINTOUT	.0	1.5	1.5	.0	.6	.6	.0	1.0	1.0
INQUIRY	.0	2.6	2.6	.0	3.9	3.9	.0	3.2	3.2
REPORT	.1	2.1	2.3	.0	2.1	2.1	.1	2.1	2.2
REQUEST PERMISSION	.0	1.9	1.9	.0	2.6	2.6	.0	2.3	2.3
ACKNOWLEDGMENT	.0	18.6	18.6	.0	23.4	23.4	.0	21.0	21.0
ANSWER SUPPLYING INFO.	.0	1.1	1.1	.0	2.5	2.5	.0	1.8	1.8
RESPONSE CORRECTING INFO.	.0	.1	.1	.0	.3	.3	.0	.2	.2
RESPONSE UNCERTAINTY	.0	.3	.3	.0	.5	.5	.0	.4	.4
NON-TASK-RELATED COMMENT	.0	.3	.3	.0	.1	.1	.0	.2	.2
NONCODABLE	.0	.4	.4	.0	.3	.3	.0	.3	.3
	0	34	34	0	44	44	0	39	39

EXPERT/INTERMEDIATE NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	5.0	5.0	.0	7.3	7.3	.0	6.1	6.1
VERBAL HANDOFF	.0	.0	.0	.0	.3	.3	.0	.1	.1
POINTOUT	.0	1.0	1.0	.0	1.5	1.5	.0	1.3	1.3
INQUIRY	.0	3.5	3.5	.0	3.0	3.0	.0	3.3	3.3
REPORT	.0	2.0	2.0	.0	1.0	1.0	.0	1.5	1.5
REQUEST PERMISSION	.0	2.8	2.8	.0	1.5	1.5	.0	2.1	2.1
ACKNOWLEDGMENT	.0	21.8	21.8	.0	24.8	24.8	.0	23.3	23.3
ANSWER SUPPLYING INFO.	.0	1.5	1.5	.0	1.3	1.3	.0	1.4	1.4
RESPONSE CORRECTING INFO.	.0	.3	.3	.0	.3	.3	.0	.3	.3
RESPONSE UNCERTAINTY	.0	.8	.8	.0	1.0	1.0	.0	.9	.9
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	.5	.5	.0	.3	.3	.0	.4	.4
	0	39	39	0	42	42	0	41	41

Summary of Ground-Line Turn Frequencies and Percentages by Team Type

INTERMEDIATE/INT. ESTABLISHED	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	4.9	4.9	.0	5.0	5.0	.0	5.0	5.0
VERBAL HANDOFF	.0	.3	.3	.0	.8	.8	.0	.5	.5
POINTOUT	.0	2.0	2.0	.0	.3	.3	.0	1.1	1.1
INQUIRY	.0	1.4	1.4	.0	2.7	2.7	.0	2.0	2.0
REPORT	.0	.8	.8	.0	2.1	2.1	.0	1.4	1.4
REQUEST PERMISSION	.0	3.3	3.3	.0	2.3	2.3	.0	2.8	2.8
ACKNOWLEDGMENT	.0	19.5	19.5	.0	23.2	23.2	.0	21.4	21.4
ANSWER SUPPLYING INFO.	.0	1.0	1.0	.0	3.2	3.2	.0	2.1	2.1
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	.0	.8	.8	.0	.5	.5	.0	.6	.6
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	.3	.3	.0	.8	.8	.0	.5	.5
	0	34	34	0	41	41	0	37	37

INTERMEDIATE/INT. NEW	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	3.5	3.5	.0	6.5	6.5	.0	5.0	5.0
VERBAL HANDOFF	.0	.0	.0	.0	.0	.0	.0	.0	.0
POINTOUT	.0	3.0	3.0	.0	1.5	1.5	.0	2.3	2.3
INQUIRY	.0	1.5	1.5	.0	2.0	2.0	.0	1.8	1.8
REPORT	.0	3.0	3.0	.0	2.0	2.0	.0	2.5	2.5
REQUEST PERMISSION	.0	3.0	3.0	.0	2.0	2.0	.0	2.5	2.5
ACKNOWLEDGMENT	.0	24.5	24.5	.0	26.0	26.0	.0	25.3	25.3
ANSWER SUPPLYING INFO.	.0	1.0	1.0	.0	5.5	5.5	.0	3.3	3.3
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.5	.5	.0	.3	.3
RESPONSE UNCERTAINTY	.0	1.0	1.0	.0	.5	.5	.0	.8	.8
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	2.0	2.0	.0	.0	.0	.0	1.0	1.0
	0	43	43	0	47	47	0	45	45

Summary of Ground-Line Turn Frequencies and Percentages by Team Type

NOVICE/NOVICE NEW

	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	5.9	5.9	.0	5.2	5.2	.0	5.5	5.5
VERBAL HANDOFF	.0	.4	.4	.0	1.3	1.3	.0	.8	.8
POINTOUT	.0	1.9	1.9	.0	1.1	1.1	.0	1.5	1.5
INQUIRY	.0	1.5	1.5	.0	2.3	2.3	.0	1.9	1.9
REPORT	.0	1.3	1.3	.0	1.8	1.8	.0	1.5	1.5
REQUEST PERMISSION	.0	3.1	3.1	.0	2.8	2.8	.0	3.0	3.0
ACKNOWLEDGMENT	.0	19.8	19.8	.0	22.3	22.3	.0	21.0	21.0
ANSWER SUPPLYING INFO.	.0	.8	.8	.0	2.2	2.2	.0	1.5	1.5
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	.0	.4	.4	.0	1.3	1.3	.0	.8	.8
NON-TASK-RELATED COMMENT	.0	.4	.4	.0	.1	.1	.0	.3	.3
NONCODABLE	.0	.0	.0	.0	.1	.1	.0	.1	.1
	0	35	35	0	41	41	0	38	38

NOVICE/NOVICE 2ND NEW

	MODERATE			HEAVY			COMBINED		
	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL	R-SIDE	D-SIDE	TOTAL
COMMAND	.0	4.8	4.8	.0	8.0	8.0	.0	6.4	6.4
VERBAL HANDOFF	.0	.0	.0	.0	.5	.5	.0	.3	.3
POINTOUT	.0	2.5	2.5	.0	1.3	1.3	.0	1.9	1.9
INQUIRY	.0	2.0	2.0	.0	1.5	1.5	.0	1.8	1.8
REPORT	.0	1.8	1.8	.0	.8	.8	.0	1.3	1.3
REQUEST PERMISSION	.0	2.8	2.8	.0	2.5	2.5	.0	2.6	2.6
ACKNOWLEDGMENT	.0	24.8	24.8	.0	28.3	28.3	.0	26.5	26.5
ANSWER SUPPLYING INFO.	.0	2.0	2.0	.0	3.0	3.0	.0	2.5	2.5
RESPONSE CORRECTING INFO.	.0	.0	.0	.0	.0	.0	.0	.0	.0
RESPONSE UNCERTAINTY	.0	1.0	1.0	.0	.8	.8	.0	.9	.9
NON-TASK-RELATED COMMENT	.0	.0	.0	.0	.0	.0	.0	.0	.0
NONCODABLE	.0	.0	.0	.0	.0	.0	.0	.0	.0
	0	42	42	0	47	47	0	44	44

C-3.0 ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	1393.437	199.062	1.799	.1055
WORKLOAD	1	218.753	218.753	1.977	.1652
TEAM TYPE * W...	7	273.938	39.134	.354	.9249
Residual	56	6195.375	110.632		

Dependent: GROUND-LINE TASK

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	15.743	2.249	.752	.6295
WORKLOAD	1	26.706	26.706	8.928	.0042
TEAM TYPE * W...	7	49.213	7.030	2.350	.0354
Residual	56	167.519	2.991		

Dependent: COMMAND

Means Table
Effect: WORKLOAD
Dependent: COMMAND

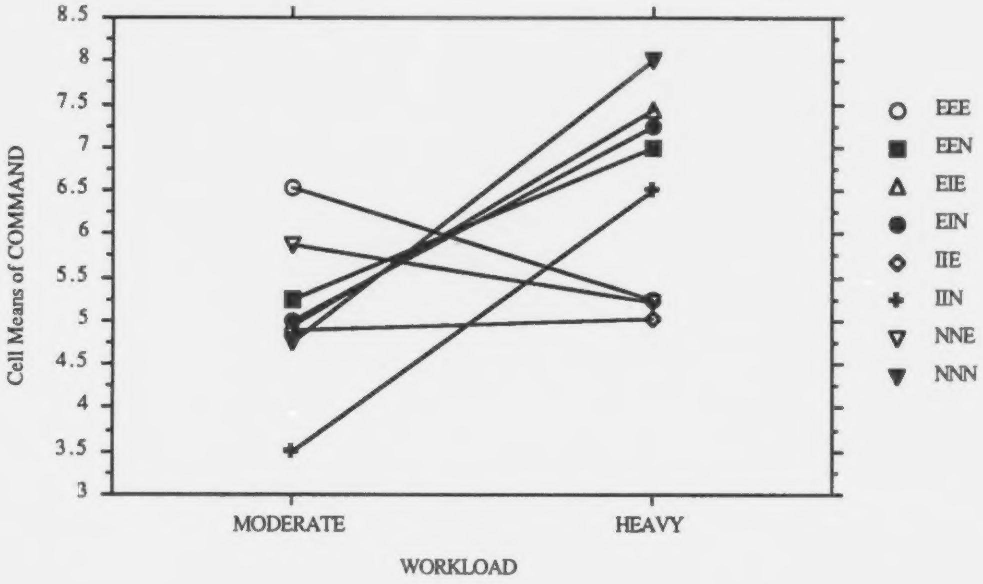
	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	5.239	1.476	.246
HEAVY	36	6.397	2.113	.352

ANOVA's: Ground-Line Communication for Team Type

Means Table
Effect: TEAM TYPE * WORKLOAD
Dependent: COMMAND

	Count	Mean	Std. Dev.	Std. Error
EEE, MODERATE	4	6.525	1.752	.876
EEE, HEAVY	4	5.250	.957	.479
EEN, MODERATE	2	5.250	.354	.250
EEN, HEAVY	2	7.000	2.828	2.000
EIE, MODERATE	8	4.938	1.016	.359
EIE, HEAVY	8	7.438	2.290	.810
EIN, MODERATE	4	5.000	.816	.408
EIN, HEAVY	4	7.250	2.062	1.031
IIE, MODERATE	4	4.875	1.031	.515
IIE, HEAVY	4	5.025	.858	.429
IIN, MODERATE	2	3.500	.707	.500
IIN, HEAVY	2	6.500	.707	.500
NNE, MODERATE	8	5.875	1.959	.693
NNE, HEAVY	8	5.213	1.954	.691
NNN, MODERATE	4	4.750	1.708	.854
NNN, HEAVY	4	8.000	2.582	1.291

Interaction Plot
Effect: TEAM TYPE * WORKLOAD
Dependent: COMMAND



ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	6.547	.935	2.017	.0689
WORKLOAD	1	1.188	1.188	2.563	.1150
TEAM TYPE * W...	7	2.172	.310	.669	.6971
Residual	56	25.969	.464		

Dependent: HANDOFF

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	16.389	2.341	2.019	.0686
WORKLOAD	1	9.067	9.067	7.817	.0071
TEAM TYPE * W...	7	6.972	.996	.859	.5445
Residual	56	64.949	1.160		

Dependent: POINTOUT

Means Table
Effect: WORKLOAD
Dependent: POINTOUT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	1.633	1.218	.203
HEAVY	36	.847	1.020	.170

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	31.676	4.525	.805	.5864
WORKLOAD	1	1.950	1.950	.347	.5581
TEAM TYPE * W...	7	9.221	1.317	.234	.9751
Residual	56	314.654	5.619		

Dependent: INQUIRY

ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	16.444	2.349	1.115	.3671
WORKLOAD	1	.710	.710	.337	.5640
TEAM TYPE * W...	7	10.869	1.553	.737	.6418
Residual	56	118.031	2.108		

Dependent: REPORT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	33.830	4.833	1.072	.3936
WORKLOAD	1	2.438	2.438	.541	.4652
TEAM TYPE * W...	7	7.620	1.089	.241	.9729
Residual	56	252.501	4.509		

Dependent: REQUEST

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	958.007	136.858	3.212	.0062
WORKLOAD	1	56.003	56.003	1.314	.2565
TEAM TYPE * W...	7	82.924	11.846	.278	.9600
Residual	56	2386.125	42.609		

Dependent: ACKNOWLEDGMENT

Means Table
Effect: TEAM TYPE
Dependent: ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
EEE	8	13.875	3.603	1.274
EEN	4	14.000	3.162	1.581
EIE	16	21.000	5.465	1.366
EIN	8	23.250	7.778	2.750
IIE	8	21.375	6.610	2.337
IIN	4	25.250	3.403	1.702
NNE	16	21.062	8.201	2.050
NNN	8	26.500	6.164	2.179

ANOVA's: Ground-Line Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: ACKNOWLEDGMENT
Significance level: .05

	Vs.	Diff.	Crit. diff.	
EEE	EEN	.125	6.942	
	EIE	7.125	7.309	
	NNE	7.188	7.549	
	IIE	7.500	7.691	
	EIN	9.375	7.843	S
	IIN	11.375	7.946	S
	NNN	12.625	8.039	S
EEN	EIE	7.000	6.942	S
	NNE	7.062	7.309	
	IIE	7.375	7.549	
	EIN	9.250	7.691	S
	IIN	11.250	7.843	S
	NNN	12.500	7.946	S
EIE	NNE	.062	6.942	
	IIE	.375	7.309	
	EIN	2.250	7.549	
	IIN	4.250	7.691	
	NNN	5.500	7.843	
NNE	IIE	.312	6.942	
	EIN	2.188	7.309	
	IIN	4.188	7.549	
	NNN	5.438	7.691	
IIE	EIN	1.875	6.942	
	IIN	3.875	7.309	
	NNN	5.125	7.549	
EIN	IIN	2.000	6.942	
	NNN	3.250	7.309	
IIN	NNN	1.250	6.942	

S = Significantly different at this level.

ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	24.830	3.547	1.657	.1386
WORKLOAD	1	36.623	36.623	17.109	.0001
TEAM TYPE * W...	7	25.119	3.588	1.676	.1336
Residual	56	119.869	2.141		

Dependent: ANSWER SUPP INFO

Means Table
Effect: WORKLOAD
Dependent: ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
MODERATE	36	1.264	1.209	.201
HEAVY	36	2.789	1.842	.307

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	.720	.103	1.550	.1697
WORKLOAD	1	.105	.105	1.582	.2137
TEAM TYPE * W...	7	.304	.043	.654	.7098
Residual	56	3.719	.066		

Dependent: RESPONSE CORRECTING

ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	7.427	1.061	.863	.5413
WORKLOAD	1	1.635	1.635	1.330	.2538
TEAM TYPE * W...	7	11.019	1.574	1.280	.2769
Residual	56	68.864	1.230		

Dependent: RESPONSE UNCERTAINTY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	.882	.126	.773	.6122
WORKLOAD	1	.031	.031	.192	.6631
TEAM TYPE * W...	7	.187	.027	.164	.9912
Residual	56	9.125	.163		

Dependent: NON-TASK

ANOVA's: Ground-Line Communication for Team Type

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
TEAM TYPE	7	8.611	1.230	2.375	.0337
WORKLOAD	1	1.681	1.681	3.245	.0770
TEAM TYPE * W...	7	5.000	.714	1.379	.2322
Residual	56	29.000	.518		

Dependent: NON-CODE

Means Table
Effect: TEAM TYPE
Dependent: NON-CODE

	Count	Mean	Std. Dev.	Std. Error
EEE	8	.750	.886	.313
EEN	4	1.250	.957	.479
EIE	16	.312	.479	.120
EIN	8	.375	.518	.183
IIE	8	.500	1.069	.378
IIN	4	1.000	2.000	1.000
NNE	16	.062	.250	.062
NNN	8	0.000	0.000	0.000

ANOVA's: Ground-Line Communication for Team Type

Duncan New Multiple Range
Effect: TEAM TYPE
Dependent: NON-CODE
Significance level: .05

	Vs.	Diff.	Crit. diff.	
NNN	NNE	.062	.765	
	EIE	.312	.806	
	EIN	.375	.832	
	IIE	.500	.848	
	EEE	.750	.865	
	IIN	1.000	.876	S
	EEN	1.250	.886	S
NNE	EIE	.250	.765	
	EIN	.312	.806	
	IIE	.438	.832	
	EEE	.688	.848	
	IIN	.938	.865	S
	EEN	1.188	.876	S
EIE	EIN	.062	.765	
	IIE	.188	.806	
	EEE	.438	.832	
	IIN	.688	.848	
	EEN	.938	.865	S
EIN	IIE	.125	.765	
	EEE	.375	.806	
	IIN	.625	.832	
	EEN	.875	.848	S
IIE	EEE	.250	.765	
	IIN	.500	.806	
	EEN	.750	.832	
EEE	IIN	.250	.765	
	EEN	.500	.806	
IIN	EEN	.250	.765	

S = Significantly different at this level.

C-4.0 ANOVA's: Ground-Line SME Overall Team Operation

Type III Sums of Squares

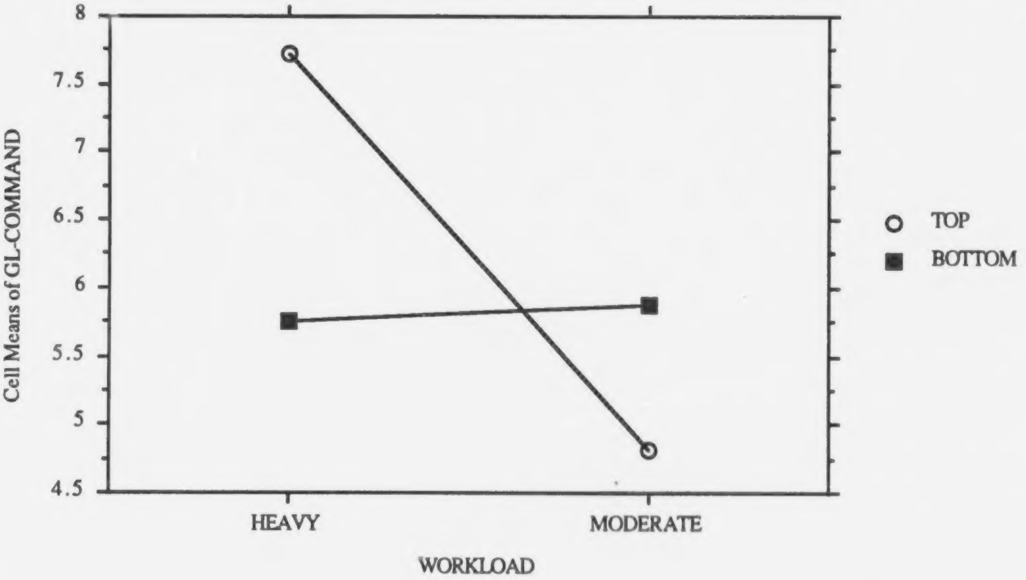
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	1.795	1.795	.404	.5294
WORKLOAD	1	16.738	16.738	3.770	.0610
PERFORM-SME ...	1	19.895	19.895	4.481	.0421
Residual	32	142.065	4.440		

Dependent: GL-COMMAND

Means Table
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP, HEAVY	7	7.714	2.628	.993
TOP, MODERATE	11	4.818	1.055	.318
BOTTOM, HEAVY	10	5.750	2.508	.793
BOTTOM, MODERATE	8	5.875	2.167	.766

Interaction Plot
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-COMMAND



ANOVA's: Ground-Line SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	2.211	2.211	4.455	.0427
WORKLOAD	1	3.643	3.643	7.341	.0107
PERFORM-SME ...	1	2.211	2.211	4.455	.0427
Residual	32	15.882	.496		

Dependent: GL-HANDOFF

Means Table
Effect: PERFORM-SME
Dependent: GL-HANDOFF

	Count	Mean	Std. Dev.	Std. Error
TOP	18	.056	.236	.056
BOTTOM	18	.639	1.109	.261

Means Table
Effect: WORKLOAD
Dependent: GL-HANDOFF

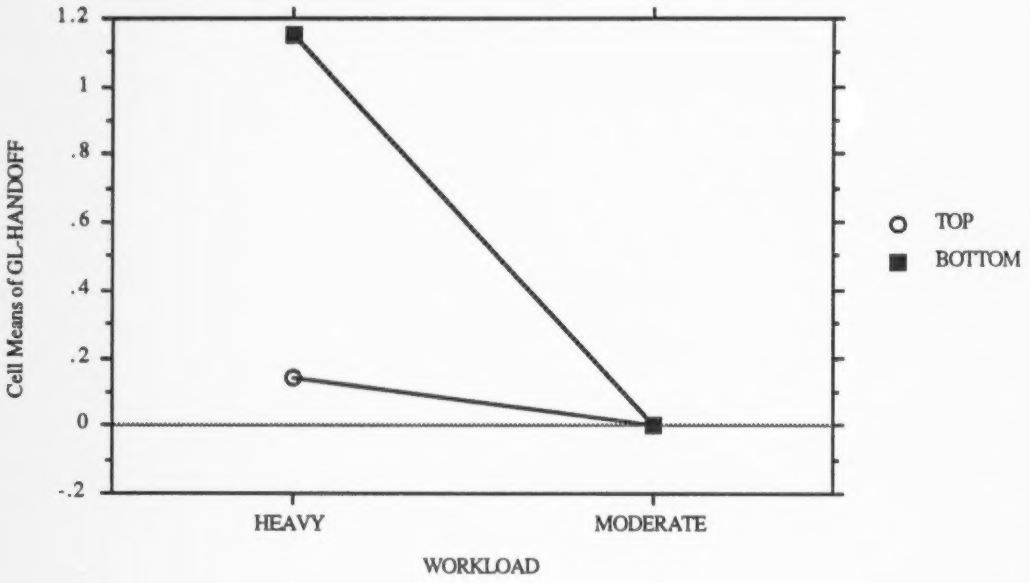
	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	.735	1.120	.272
MODERATE	19	0.000	0.000	0.000

Means Table
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-HANDOFF

	Count	Mean	Std. Dev.	Std. Error
TOP, HEAVY	7	.143	.378	.143
TOP, MODERATE	11	0.000	0.000	0.000
BOTTOM, HEAVY	10	1.150	1.292	.409
BOTTOM, MODERATE	8	0.000	0.000	0.000

ANOVA's: Ground-Line SME Overall Team Operation

Interaction Plot
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-HANDOFF



ANOVA's: Ground-Line SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	6.656	6.656	4.842	.0351
WORKLOAD	1	9.056	9.056	6.589	.0151
PERFORM-SME ...	1	.249	.249	.182	.6729
Residual	32	43.984	1.375		

Dependent: GL-POINTOUT

Means Table
Effect: PERFORM-SME
Dependent: GL-POINTOUT

	Count	Mean	Std. Dev.	Std. Error
TOP	18	1.083	1.141	.269
BOTTOM	18	1.778	1.353	.319

Means Table
Effect: WORKLOAD
Dependent: GL-POINTOUT

	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	.971	1.125	.273
MODERATE	19	1.842	1.302	.299

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	7.319	7.319	1.505	.2289
WORKLOAD	1	14.691	14.691	3.020	.0919
PERFORM-SME ...	1	10.513	10.513	2.161	.1513
Residual	32	155.665	4.865		

Dependent: GL-INQUIRY

ANOVA's: Ground-Line SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	3.695	3.695	1.656	.2074
WORKLOAD	1	.001	.001	2.57E-4	.9873
PERFORM-SME ...	1	.510	.510	.229	.6358
Residual	32	71.391	2.231		

Dependent: GL-REPORT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.144	.144	.027	.8700
WORKLOAD	1	1.849	1.849	.348	.5593
PERFORM-SME ...	1	21.340	21.340	4.018	.0535
Residual	32	169.965	5.311		

Dependent: GL-REQUEST

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	17.669	17.669	.245	.6239
WORKLOAD	1	19.955	19.955	.277	.6024
PERFORM-SME ...	1	29.449	29.449	.409	.5272
Residual	32	2305.949	72.061		

Dependent: GL-ACKNOWLEDGMENT

ANOVA's: Ground-Line SME Overall Team Operation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.180	.180	.176	.6779
WORKLOAD	1	4.461	4.461	4.345	.0452
PERFORM-SME ...	1	.480	.480	.468	.4988
Residual	32	32.848	1.027		

Dependent: GL-ANSWER SUPP INFO

Means Table
Effect: WORKLOAD
Dependent: GL-ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
HEAVY	17	1.794	.953	.231
MODERATE	19	1.053	1.026	.235

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.201	.201	2.483	.1250
WORKLOAD	1	.201	.201	2.483	.1250
PERFORM-SME ...	1	.668	.668	8.255	.0072
Residual	32	2.589	.081		

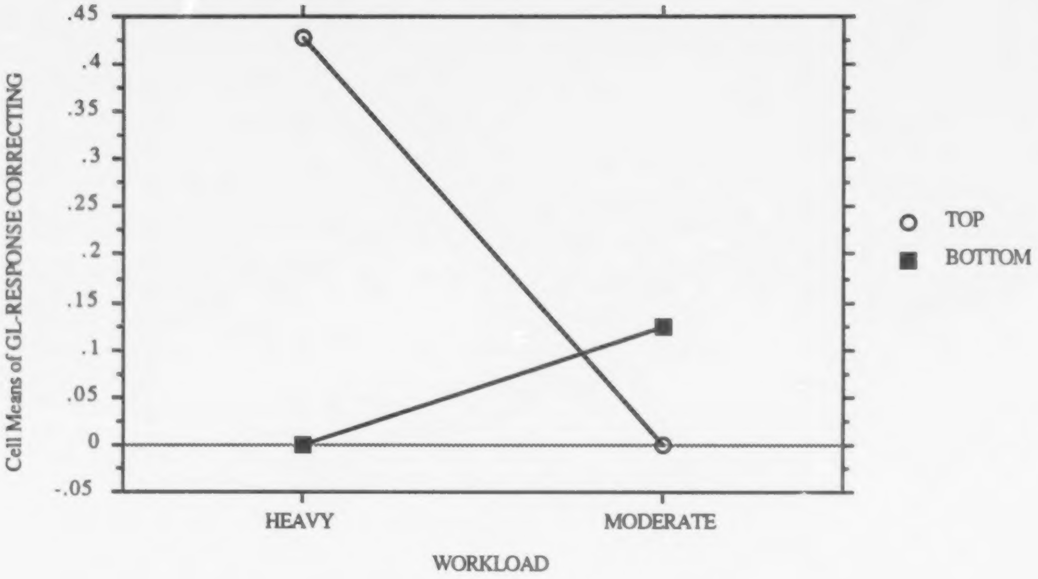
Dependent: GL-RESPONSE CORRECTING

Means Table
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-RESPONSE CORRECTING

	Count	Mean	Std. Dev.	Std. Error
TOP, HEAVY	7	.429	.535	.202
TOP, MODERATE	11	0.000	0.000	0.000
BOTTOM, HEAVY	10	0.000	0.000	0.000
BOTTOM, MODERATE	8	.125	.354	.125

ANOVA's: Ground-Line SME Overall Team Operation

Interaction Plot
Effect: PERFORM-SME * WORKLOAD
Dependent: GL-RESPONSE CORRECTING



Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	3.611	3.611	3.270	.0800
WORKLOAD	1	.280	.280	.254	.6180
PERFORM-SME ...	1	3.360	3.360	3.043	.0907
Residual	32	35.335	1.104		

Dependent: GL-RESPONSE UNCERTAINTY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.062	.062	.246	.6236
WORKLOAD	1	.240	.240	.956	.3356
PERFORM-SME ...	1	.002	.002	.009	.9259
Residual	32	8.036	.251		

Dependent: GL-NON-TASK

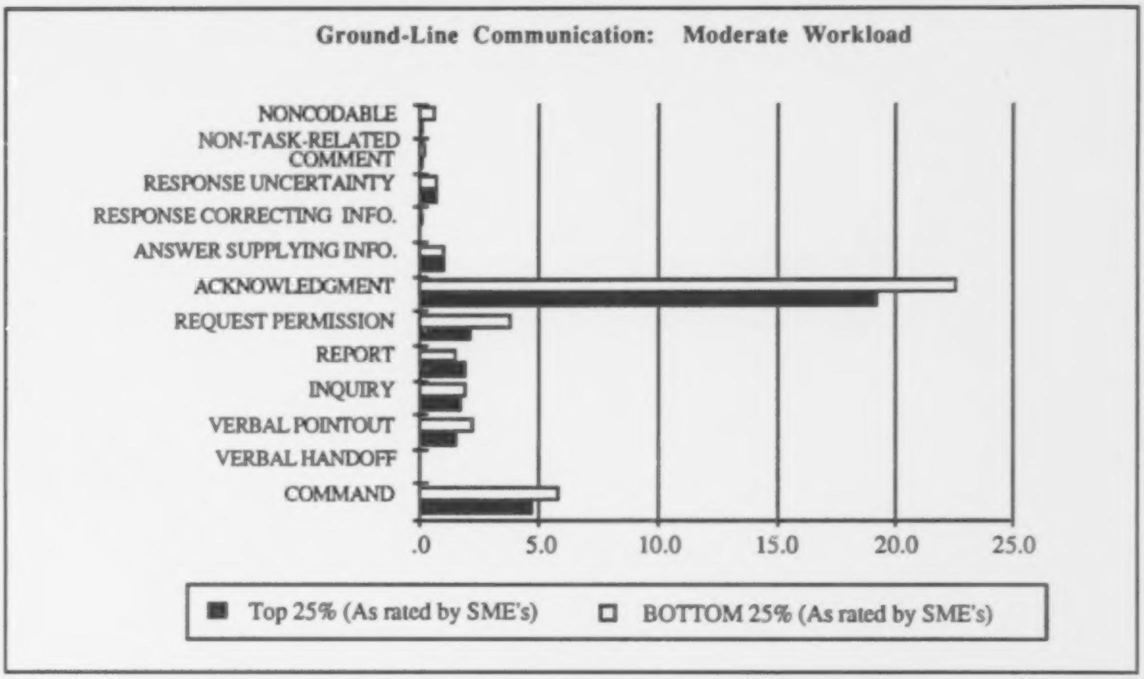
ANOVA's: Ground-Line SME Overall Team Operation

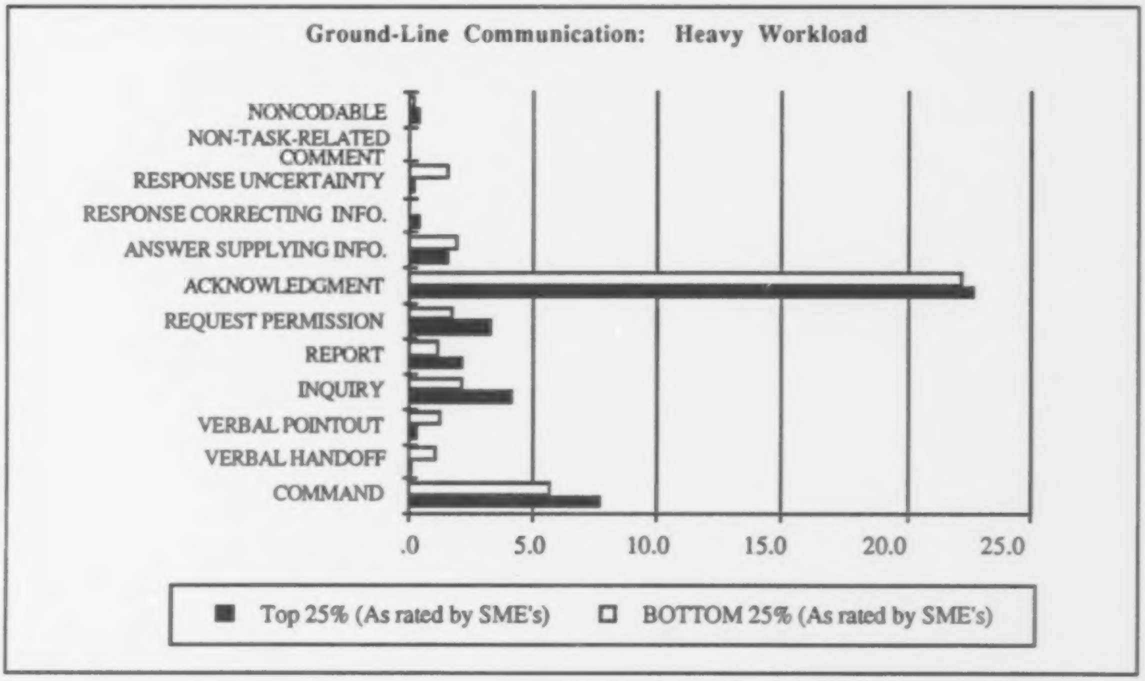
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-SME	1	.216	.216	.324	.5733
WORKLOAD	1	.013	.013	.020	.8884
PERFORM-SME ...	1	.713	.713	1.069	.3089
Residual	32	21.326	.666		

Dependent: GL-NON-CODE

C-4.1 Charts of the SME Overall Team Operation Ratings





C-5.0 ANOVA's: Ground-Line Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.329	.329	.108	.7446
WORKLOAD	1	11.097	11.097	3.647	.0652
PERFORM-NONR ...	1	1.010	1.010	.332	.5685
Residual	32	97.378	3.043		

Dependent: GL-COMMAND

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.205	.205	.532	.4711
WORKLOAD	1	2.478	2.478	6.432	.0163
PERFORM-NONR ...	1	.565	.565	1.467	.2347
Residual	32	12.331	.385		

Dependent: GL-HANDOFF

Means Table
Effect: WORKLOAD
Dependent: GL-HANDOFF

	Count	Mean	Std. Dev.	Std. Error
MODERATE	19	.053	.229	.053
HEAVY	17	.588	.870	.211

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	3.893	3.893	2.865	.1003
WORKLOAD	1	3.265	3.265	2.402	.1310
PERFORM-NONR ...	1	.656	.656	.483	.4922
Residual	32	43.486	1.359		

Dependent: GL-POINTOUT

ANOVA's: Ground-Line Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	1.411	1.411	.251	.6198
WORKLOAD	1	2.413	2.413	.429	.5171
PERFORM-NONR ...	1	1.221	1.221	.217	.6444
Residual	32	179.956	5.624		

Dependent: GL-INQUIRY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	4.558	4.558	2.291	.1400
WORKLOAD	1	.075	.075	.038	.8471
PERFORM-NONR ...	1	5.143	5.143	2.585	.1177
Residual	32	63.678	1.990		

Dependent: GL-REPORT

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	6.067	6.067	1.922	.1753
WORKLOAD	1	5.744	5.744	1.819	.1869
PERFORM-NONR ...	1	.005	.005	.002	.9685
Residual	32	101.031	3.157		

Dependent: GL-REQUEST

ANOVA's: Ground-Line Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	246.000	246.000	6.044	.0195
WORKLOAD	1	230.613	230.613	5.666	.0234
PERFORM-NONR ...	1	19.532	19.532	.480	.4935
Residual	32	1302.456	40.702		

Dependent: GL-ACKNOWLEDGMENT

Means Table
Effect: PERFORM-NONR
Dependent: GL-ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
TOP	18	18.500	6.336	1.493
BOTTOM	18	23.944	7.158	1.687

Means Table
Effect: WORKLOAD
Dependent: GL-ACKNOWLEDGMENT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	19	18.684	5.386	1.236
HEAVY	17	24.059	8.058	1.954

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.431	.431	.187	.6686
WORKLOAD	1	22.501	22.501	9.754	.0038
PERFORM-NONR ...	1	1.184	1.184	.513	.4789
Residual	32	73.822	2.307		

Dependent: GL-ANSWER SUPP INFO

Means Table
Effect: WORKLOAD
Dependent: GL-ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
MODERATE	19	1.368	1.116	.256
HEAVY	17	2.941	1.819	.441

ANOVA's: Ground-Line Nonroutine Communication Performance

Type III Sums of Squares

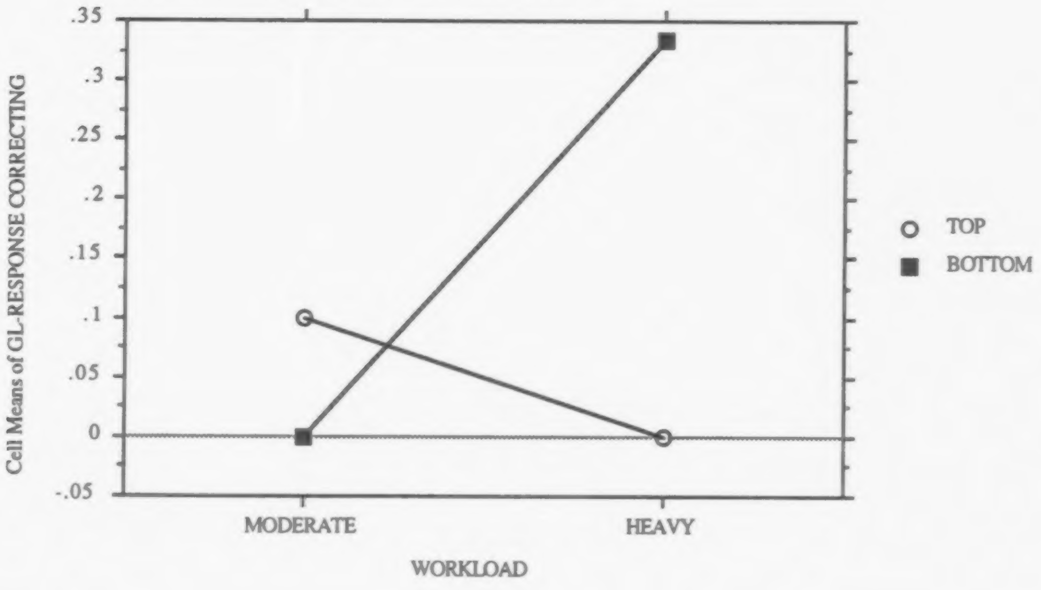
Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.122	.122	1.343	.2550
WORKLOAD	1	.122	.122	1.343	.2550
PERFORM-NONR ...	1	.420	.420	4.633	.0390
Residual	32	2.900	.091		

Dependent: GL-RESPONSE CORRECTING

Means Table
Effect: PERFORM-NONR * WORKLOAD
Dependent: GL-RESPONSE CORRECTING

	Count	Mean	Std. Dev.	Std. Error
TOP, MODERATE	10	.100	.316	.100
TOP, HEAVY	8	0.000	0.000	0.000
BOTTOM, MODERATE	9	0.000	0.000	0.000
BOTTOM, HEAVY	9	.333	.500	.167

Interaction Plot
Effect: PERFORM-NONR * WORKLOAD
Dependent: GL-RESPONSE CORRECTING



ANOVA's: Ground-Line Nonroutine Communication Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	5.784	5.784	4.660	.0385
WORKLOAD	1	.768	.768	.619	.4373
PERFORM-NONR ...	1	.296	.296	.239	.6286
Residual	32	39.719	1.241		

Dependent: GL-RESPONSE UNCERTAINTY

Means Table
Effect: PERFORM-NONR
Dependent: GL-RESPONSE UNCERTAINTY

	Count	Mean	Std. Dev.	Std. Error
TOP	18	.389	.698	.164
BOTTOM	18	1.167	1.383	.326

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.089	.089	.795	.3792
WORKLOAD	1	.089	.089	.795	.3792
PERFORM-NONR ...	1	.089	.089	.795	.3792
Residual	32	3.600	.113		

Dependent: GL-NON-TASK

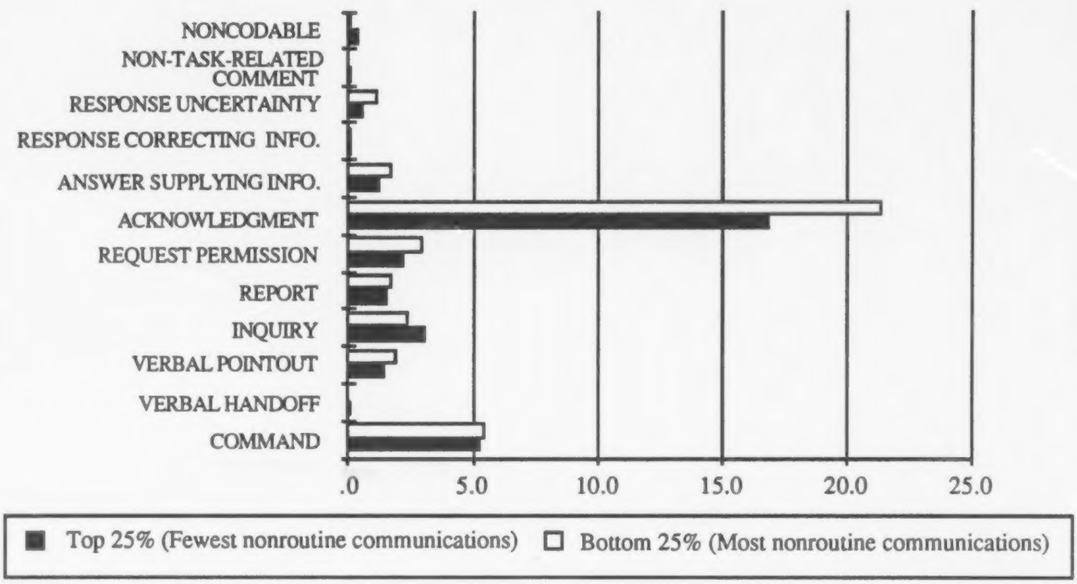
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-NONR	1	.224	.224	.694	.4111
WORKLOAD	1	.003	.003	.010	.9192
PERFORM-NONR ...	1	.152	.152	.472	.4972
Residual	32	10.344	.323		

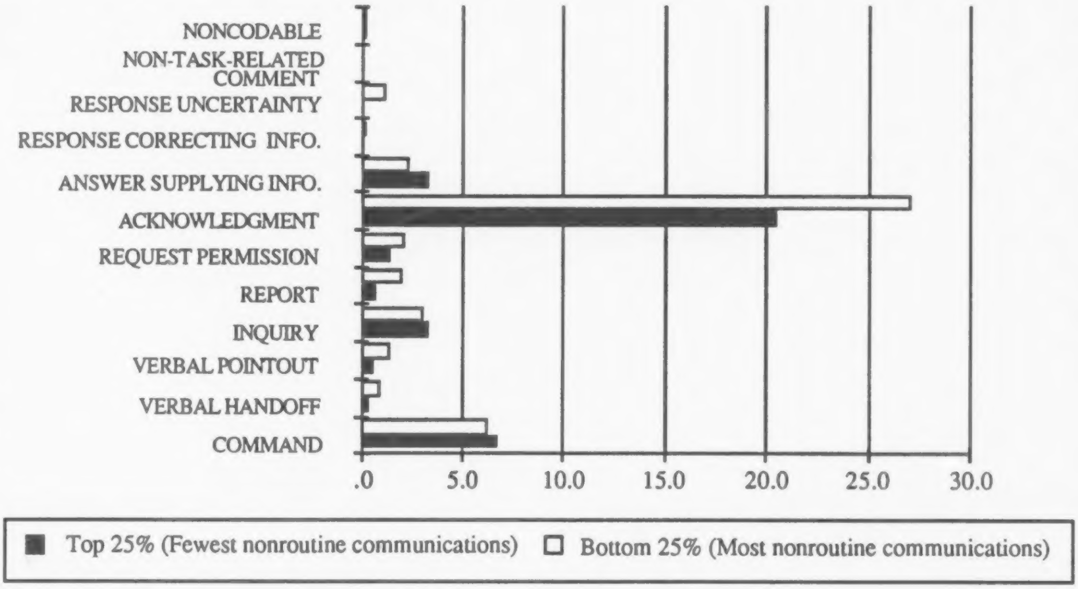
Dependent: GL-NON-CODE

C-5.1 Charts of Ground-Line Nonroutine Communication Performance

Ground-Line Communication: Moderate Workload



Ground-Line Communication: Heavy Workload



C-6.0 ANOVA's: Ground-Line Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	6.672	6.672	3.885	.0574
WORKLOAD	1	9.006	9.006	5.243	.0288
PERFORM-INAC ...	1	.144	.144	.084	.7738
Residual	32	54.961	1.718		

Dependent: GL-COMMAND

Means Table
Effect: PERFORM-INAC
Dependent: GL-COMMAND

	Count	Mean	Std. Dev.	Std. Error
TOP	18	5.167	1.200	.283
BOTTOM	18	6.278	1.526	.360

Means Table
Effect: WORKLOAD
Dependent: GL-COMMAND

	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	5.111	1.231	.290
HEAVY	18	6.333	1.455	.343

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.144	.144	.188	.6677
WORKLOAD	1	1.478	1.478	1.922	.1752
PERFORM-INAC ...	1	.369	.369	.481	.4932
Residual	32	24.597	.769		

Dependent: GL-HANDOFF

ANOVA's: Ground-Line Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	1.052	1.052	.916	.3457
WORKLOAD	1	7.274	7.274	6.333	.0171
PERFORM-INAC ...	1	2.195	2.195	1.911	.1764
Residual	32	36.753	1.149		

Dependent: GL-POINTOUT

Means Table
Effect: WORKLOAD
Dependent: GL-POINTOUT

	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	1.667	1.283	.302
HEAVY	18	.667	.840	.198

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	5.458	5.458	1.101	.3020
WORKLOAD	1	1.013	1.013	.204	.6543
PERFORM-INAC ...	1	1.256	1.256	.253	.6182
Residual	32	158.675	4.959		

Dependent: GL-INQUIRY

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	1.256	1.256	.318	.5768
WORKLOAD	1	1.922	1.922	.487	.4905
PERFORM-INAC ...	1	2.606	2.606	.660	.4226
Residual	32	126.416	3.950		

Dependent: GL-REQUEST

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	26.886	26.886	.599	.4445
WORKLOAD	1	65.775	65.775	1.467	.2348
PERFORM-INAC ...	1	5.282	5.282	.118	.7337
Residual	32	1435.221	44.851		

Dependent: GL-ACKNOWLEDGMENT

ANOVA's: Ground-Line Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.347	.347	.114	.7379
WORKLOAD	1	15.458	15.458	5.082	.0311
PERFORM-INAC ...	1	1.718	1.718	.565	.4579
Residual	32	97.325	3.041		

Dependent: GL-ANSWER SUPP INFO

Means Table
Effect: WORKLOAD
Dependent: GL-ANSWER SUPP INFO

	Count	Mean	Std. Dev.	Std. Error
MODERATE	18	1.722	1.406	.331
HEAVY	18	3.111	1.967	.464

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.044	.044	1.630	.2109
WORKLOAD	1	.044	.044	1.630	.2109
PERFORM-INAC ...	1	.044	.044	1.630	.2109
Residual	32	.857	.027		

Dependent: GL-RESPONSE CORRECTING

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	3.977	3.977	2.860	.1005
WORKLOAD	1	.866	.866	.623	.4358
PERFORM-INAC ...	1	.029	.029	.021	.8856
Residual	32	44.494	1.390		

Dependent: GL-RESPONSE UNCERTAINTY

ANOVA's: Ground-Line Communication Inaccuracy Performance

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	3.929E-40	3.929E-40	6.9E-39	1.0000
WORKLOAD	1	3.929E-40	3.929E-40	6.9E-39	1.0000
PERFORM-INAC ...	1	.071	.071	1.244	.2729
Residual	32	1.818	.057		

Dependent: GL-NON-TASK

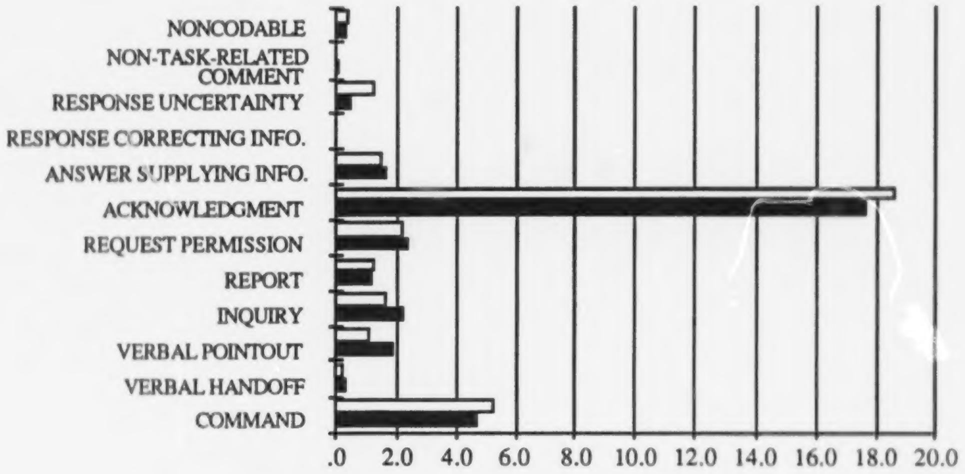
Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
PERFORM-INAC	1	.006	.006	.016	.9015
WORKLOAD	1	.117	.117	.315	.5785
PERFORM-INAC ...	1	.013	.013	.035	.8528
Residual	32	11.870	.371		

Dependent: GL-NON-CODE

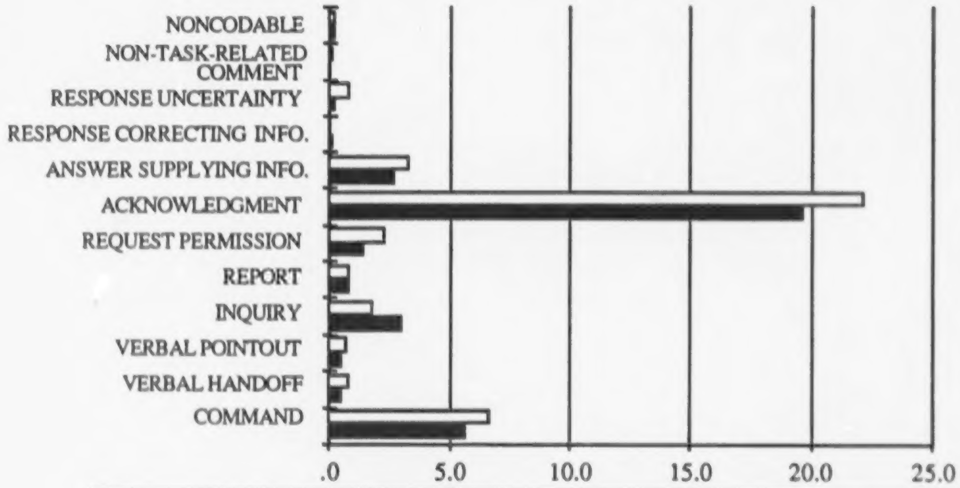
C-6.1 Charts for Ground-Line Communication Inaccuracy Performance

Ground-Line Communication: Moderate Workload



■ Top 25% (Fewest inaccuracies) ☐ Bottom 25% (Most inaccuracies)

Ground-Line Communication: Moderate Workload



■ Top 25% (Fewest inaccuracies) ☐ Bottom 25% (Most inaccuracies)

C-7.0 Ground-Line Correlations-Objective

Correlation Matrix for Variables: $X_1 \dots X_8$

	SME-OVE	INACCUR	NONROUT	L-COMM	L-HANDO	L-POINTO	L-INQUIRY	L-REPORT
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
L-COMM	.01	.09	-.01	1				
L-HANDO	-.27	.12	.02	-.07	1			
L-POINTO	-.19	-.02	.15	-.22	.01	1		
L-INQUIRY	.08	-.23	-.06	.25	.11	-.08	1	
L-REPORT	.13	-.13	.18	-.15	-.05	3.18E-3	.23	1

Correlation Matrix for Variables: $X_1 \dots X_8$

	SME-OVE	INACCUR	NONROUT	L-REQUEST	L-ACKNO	L-ANSWE	L-RCOR	L-RUNCE
SME-OVE	1							
INACCUR	-.53	1						
NONROUT	-.21	.19	1					
L-REQUEST	.04	.11	.11	1				
L-ACKNO	-.16	.12	.2	.39	1			
L-ANSWE	-.12	.06	-.14	-.25	.06	1		
L-RCORR	.1	-.16	.15	.21	.31	-.07	1	
L-RUNCE	-.23	.23	.24	-.08	-.04	.08	-.12	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
L-COMM	Ground-Line – Command
L-HANDO	Ground-Line – Verbal Handoffs
L-POINTO	Ground-Line – Verbal Pointouts
L-INQUIRY	Ground-Line – Inquiry
L-REPORT	Ground-Line – Report
L-REQUEST	Ground-Line – Request Permission
L-ACKNO	Ground-Line – Acknowledgment
L-ANSWE	Ground-Line – Answer Supplying Information
L-RCORR	Ground-Line – Response Correcting Presented Information
L-RUNCE	Ground-Line – Response Uncertainty

Note: To be statistically significant at the $p<.05$ level, a correlation must be .231 or higher.

Ground-Line Correlations-Objective

Correlation Matrix for Variables: X_1 ... X_5

	SME-OVE	INACCUR	NONROUT	L-NONTAS	L-NONCODE
SME-OVE	1				
INACCUR	-.53	1			
NONROUT	-.21	.19	1		
L-NONTAS	-.03	-.08	-.06	1	
L-NONCODE	-.06	-.05	-.03	-.08	1

Legend

SME-OVE	SME Overall Team Operation Ratings
INACCUR	Communication Inaccuracies
NONROUT	Nonroutine Communication
L-NONTAS	Ground-Line – Non-Task-Related Comment
L-NONCODE	Ground-Line – Noncodable

Note: To be statistically significant at the p<.05 level, a correlation must be .231 or higher.

APPENDIX D: LIVE TRAFFIC: COMMUNICATION CATEGORY AND CONTROLLER TASK CODING

D-3.0 List of Air Traffic Control Task Categories

Abbreviation	Task Name
DP	Develop and Revise Sector Control Plan
IA	Issue Advisory
IH	Initiate Handoff
IP	Initiate Pointout
MA	Manage Arrivals
MD	Manage Departures
MO	Manage Overflight (amendment to mental model)
MS	Maintain Situation Awareness
NC	Noncodable
RC	Resolve Aircraft Conflict
RH	Receive Handoff
RP	Receive Pointout
RR	Reroute Aircraft

D—4.0 Relationship of Communication to the Mental Model and ATC Tasks

The expert model of en route air traffic control captures the cognitive processes of the controller in terms of two components: 1) a mental model, or knowledge structure; and 2) a set of task models that describe primary goals and their corresponding subgoals.

The analysis of controller team communications addresses speech data that are by nature behavioral data. In examining the speech of air traffic controllers one is viewing the "surface" level or reflection of cognitive processes.

Task coding was undertaken with the help of an ATC subject-matter expert (SME) to clarify the relationship between behaviorally observable communication and the task goal that it supported. Below is a list of the types of communications that correspond to the ATC tasks. These types of communications usually reflect some behavior that maps onto one of the subgoals in the task. The list is not exhaustive as to the types of communications that map into each category. Also, the classification of some of these examples sometimes requires insight of the SME to differentiate, for example, route changes related to managing arrivals and those relating to rerouting.

DP Develop and Revise Sector Control Plan

Telling pilot of intended plans ("I'll have higher for you in 15 minutes")
Discussing plans or intents for future actions
Stating intent about a plane or group of planes to other controller. Again, this primarily involves statements made in future tense.

IA Issue Advisory

Making observations about traffic or weather to pilots
(ADVISE PILOT OF SITUATION)

IH Initiate Handoff

Frequency switching commands to pilots
(ISSUE NEW RADIO FREQUENCY TO PILOT)
Coordination with another sector about aircraft (e.g., "You have control for turns for AAL661")
(COORDINATE WITH RECEIVING CONTROLLER)

IP Initiate Pointout

Evidence in communication with other sector or team member about requesting a pointout on an aircraft
(REQUEST POINTOUT FROM APPROPRIATE CONTROLLER)

MA Manage Arrivals

Flight strips indicate which airplanes are arrivals
Observations made to pilots about vectoring for sequencing or approach or localizer or other fixes or navaids
(DETERMINE VECTOR/REROUTE FOR LANDING TO IMPLEMENT SEQUENCING)

D—4.0 Relationship of Communication to the Mental Model and ATC Tasks (Continued)

MA Manage Arrivals (Continued)

Descending planes in stages to comply with Approach Control letters of agreement
(IMPLEMENT PLAN FOR SEQUENCING SLOWING/DESCENDING AIRCRAFT)

References to altitudes and speeds at given fixes on approach paths (to comply with letters of agreement)
(DETERMINE VECTOR/REROUTE FOR LANDING TO MAINTAIN AIRCRAFT ON PUBLISHED ARRIVAL ROUTES IN ACCORDANCE WITH PROCEDURES)

Slowing planes to comply with letters of agreement (commonly 250 knots)
(IMPLEMENT PLAN FOR SEQUENCING SLOWING/DESCENDING AIRCRAFT)

When the frequency switch refers to an approach control, earlier control actions likely belonged to managing the arrival (although sometimes they involve rerouting or resolving aircraft conflict)
(HANDOFF TO APPROACH CONTROL)

APREQ's involving aircraft not completely in compliance with letters of agreement at approach controls
(HANDOFF TO APPROACH CONTROL)

MD Manage Departures

Ascending aircraft in stages to a cruise altitude from a low altitude
(MONITOR AIRCRAFT AND ISSUE CLEARANCES TO ACHIEVE FINAL ALTITUDE)

Receiving an aircraft from an approach control (flight strips indicate this)
(TRIGGER - HANDOFF ACCEPTED FROM APPROACH CONTROL SECTOR)

Handing off aircraft to higher overflight sectors

MO Manage Overflight (amendment to task model)

Controller initiated rerouting of overflights to provide better service

MS Maintain Situation Awareness

Requesting information from pilots about aircraft data such as altitude, heading, type of radio, etc.
(RESOLVE INCONSISTENCIES BETWEEN PERCEIVED AIRCRAFT DATA AND CURRENT SITUATION UNDERSTANDING)

Requesting information from the other controller about the aircraft's route or aircraft type
(DETERMINE TRAFFIC TYPE) or (PROJECT AIRCRAFT ROUTES IN TIME/DISTANCE) or (COMPARE AIRCRAFT DATA WITH CURRENT SECTOR SITUATION UNDERSTANDING)

Statements about environmental conditions or equipment (e.g., radar outage, metering system)
(DETERMINE CONDITIONS IN SECTOR)

D—4.0 Relationship of Communication to the Mental Model and ATC Tasks (Continued)

NC Noncodable

Noncodable or non-task-related comments that therefore are not part of any of the tasks

RC Resolve Aircraft Conflict

Comments between controllers about converging aircraft
(TRIGGER - TWO OR MORE AIRCRAFT CONVERGING ON SAME LATITUDE/LONGITUDE/ALTITUDE/AIRWAY)
Observations to pilots that vectors are for traffic
(IMPLEMENT PLAN)
Commands to pilots that request immediate ascent or descent through given altitudes
(IMPLEMENT PLAN)

RH Receive Handoff

Acknowledgments to pilots that include mention of the ATC Center
(MONITOR FOR INITIAL RADIO CONTACT)
Coordination with other sector about taking control of an aircraft or that radar contact has been made with an aircraft
(CALL AND COORDINATE)

RP Receive Pointout

Approvals of pointouts to other sector controllers
(UNCONDITIONALLY ACCEPT, ACCEPT WITH RESTRICTIONS, OR DENY POINTOUT)

RR Reroute Aircraft

Commands to pilot regarding route or altitude changes in response to pilot requests
(ISSUE OR DENY CLEARANCE FOR REROUTING)
Commands to pilots for routing around special use airspaces
(TRIGGER - SPECIAL USE AIRSPACE IN FLIGHT PATH)
Clearing deviations around weather
(TRIGGER - WEATHER IN FLIGHT PATH)
Discussions between controllers in same or other sector about route changes or altitude changes
(CALL AND COORDINATE)
Commands to pilots that reflect that aircraft is not in compliance with filed or cleared route
(ISSUE OR DENY CLEARANCE FOR REROUTING)

D-1.0 Team Communications Coding Categories

Acronym	Category	Description
AC:	Acknowledgment	Verbally making known that a prior speech turn was heard; does not supply additional information; does not evaluate or correct a prior speech turn.
AG:	Agreement	A response indicating concurrence with a previous speech turn; a positive evaluation of a prior speech turn.
AS:	Answer Supplying Information	A speech turn supplying information beyond mere acknowledgment or agreement.
CAR:	Command/Request Action	A specific assignment of responsibility in the form of a declarative statement or request for action.
CC:	Courtesy Comment	A statement praising another's work on a task.
CL:	Clarify Response	A response indicating that a previous speech turn was not heard and/or not understood.
COR:	Correcting Response	A response that questions the accuracy of or corrects a prior speech turn.
DI:	Disagreement	A response not in concurrence with a previous speech turn; a negative evaluation of a prior speech turn.
II:	Inquiry—Intent	A request for information about another's intended action. Includes inquiries about present and future actions, but not about previous actions. Information acknowledgment, agreement, or disagreement.
IS:	Inquiry—Situation	A request for factual information relating to past or present tasks. Not a request for action.
NC:	Noncodable	Any speech turn that is unintelligible or unclassifiable with the current coding scheme.
NT:	Non-Task-Related Comment	Any speech turn referring to something other than a task-related comment.
OB:	Observation	A remark that recognizes and/or notes a fact or occurrence relating to the task.
RP:	Repetition	Repeating a previous speech turn because it was not responded to by the receiver.

D-1.0 Team Communications Coding Categories (Continued)

Acronym	Category	Description
SI:	Statement of Intent	An announcement of intended action by the speaker. Includes statements referring to present and future actions, but not to previous actions.
SUG:	Suggestion	Suggesting a course of action directly (as a recommendation) or indirectly (as a question).

D-2.0 Guidelines Regarding Coding

Acknowledgments (AC)
Yeah, okay, all right, fine. Equivalent of "I heard you."

Statement of Intent (SI)
Comments to pilots regarding future control actions.
What either controller intends to do with a plane or a group of planes in the future.

Inquiry--Situation (IS)
R-side requests for headings, altitude from pilot.
Questions about the sector to any other controllers.

Command/Request Action (CAR)
Commands and requests for actions.
Example: Hailing an airplane to get it to call R-side.

Observation (OB)
This may be an initial speech turn.
Can also be a turn within a conversation that does not answer a question.
It provides an observation or fact.
Comments made to pilots about vectoring for traffic or sequencing.

Agreement (AG)
This intent does not answer questions.
In the spirit of Pierce categories, positive evaluation of a prior speech turn.
An answer that agrees with or approves the previous question's intent.
Clear agreement even if several words.
Pointouts approved.
Other kinds of approval re coordination with other sectors.
"Affirmative."
Yes, yeah.

Disagreements (DI)
This intent does not answer questions.
A negative evaluation of a prior speech turn.
An answer that disagrees with or disapproves the previous question's intent.
Clear disagreement even if several words.
Denying pointouts.
"No, I don't think so."
"No."
"Unable."

Answers Supplying Information (AS)
This is in reply to another speech turn.
This reply may be ambiguous as to agreement or disagreement.
This reply may be informative.
Elaborated answers to any questions including yes/no questions.
If addressing someone by name when talking to them, and this is the only content for the speech turn, code NC.

APPENDIX E: LIVE TRAFFIC ANALYSES

E-1.0 Communication Categories by Task Interaction User Information

Matrices of Task by Communication Categories Interaction

This section contains tables of the raw frequencies and percentages of each communication category type for each task by session. The tables are grouped by the following communication types:

Team Communication (R to H/D and H/D to R)
Ground-Air Communication
Ground-Line Communication

Each table shows tasks as the columns and communication category types as the rows, with the cell containing the raw frequency or percentage of that communication category type for the task.

Abbreviations:

Communication Categories:

AC	Acknowledgment
AG	Agreement
AS	Answer Supplying Info.
CAR	Command/Request Action
CC	Courtesy Comment
CL	Clarify Response Comment
COR	Correcting Response
DI	Disagreement
I I	Inquiry - Intent
IS	Inquiry - Situation
NC	Noncodable
NT	Non-Task Related
OB	Observation
RP	Repetition
SI	Statement of Intent
SUG	Suggestion

Task Types:

DP	Develop and Revise Sector Control Plan
IA	Issue Advisory
IH	Initiate Handoff
IP	Initiate Pointout
MA	Manage Arrivals
MD	Manage Departures
MO	Manage Overflights
MS	Maintain Situational Awareness
NC	Noncodable
RC	Resolve Aircraft Conflict
RH	Receive Handoff
RP	Receive Pointout
RR	Reroute Aircraft

NY 1 Team Communications R-> H/D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1							7						8
AG	1							5	1					7
AS	1							4						5
CAR	9							2						11
CC								1	1					2
CL								1						1
COR														0
DI								1						1
II	1													1
IS								8						8
NC									9					9
NT									11					11
OB	6					1		19	1					27
RP														0
SI	3													3
SUG														0
Total	22	0	0	0	0	1	0	48	23	0	0	0	0	94

NY 1 Team Communications R-> H Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	8.5%
AG	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	1.1%	0.0%	0.0%	0.0%	0.0%	7.4%
AS	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%
CAR	9.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	11.7%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	1.1%	0.0%	0.0%	0.0%	0.0%	2.1%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
II	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.5%	0.0%	0.0%	0.0%	0.0%	0.0%	8.5%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.6%	0.0%	0.0%	0.0%	0.0%	9.6%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.7%	0.0%	0.0%	0.0%	0.0%	11.7%
OB	6.4%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	20.2%	1.1%	0.0%	0.0%	0.0%	0.0%	28.7%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	23.4%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	51.1%	24.5%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 1 Team Communications H/D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1							2	1					4
AG								2						2
AS	1							7						8
CAR								2						2
CC														0
CL								1						1
COR														0
DI	1													1
II	1								1					2
IS								9						9
NC									16					16
NT									4					4
OB	4							37	1					42
RP								1	0					1
SI	2							1						3
SUG														0
Total	10	0	0	0	0	0	0	62	23	0	0	0	0	95

NY 1 Team Communications H/D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	1.1%	0.0%	0.0%	0.0%	0.0%	4.2%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%
AS	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	8.4%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
II	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	2.1%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.5%	0.0%	0.0%	0.0%	0.0%	0.0%	9.5%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.8%	0.0%	0.0%	0.0%	0.0%	16.8%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.2%	0.0%	0.0%	0.0%	0.0%	4.2%
OB	4.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	38.9%	1.1%	0.0%	0.0%	0.0%	0.0%	44.2%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
SI	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	10.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	65.3%	24.2%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 2 Team Communications R-> H/D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	5							10	1					16
AG	3							1	1					5
AS								2	1					3
CAR	4													4
CC														0
CL														0
COR														0
DI														0
II														0
IS	1							4						5
NC								1	3					4
NT									4					4
OB	5							4	1					10
RP														0
SI	3													3
SUG														0
Total	21	0	0	0	0	0	0	22	11	0	0	0	0	54

NY 2 Team Communications R-> H/D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	9.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.5%	1.9%	0.0%	0.0%	0.0%	0.0%	29.6%
AG	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	1.9%	0.0%	0.0%	0.0%	0.0%	9.3%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%	1.9%	0.0%	0.0%	0.0%	0.0%	5.6%
CAR	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	5.6%	0.0%	0.0%	0.0%	0.0%	7.4%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	7.4%
OB	9.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	1.9%	0.0%	0.0%	0.0%	0.0%	18.5%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.6%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	38.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	40.7%	20.4%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 2 Team Communications H/D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	2													2
AG														0
AS	1							4						5
CAR														0
CC														0
CL														0
COR														0
DI														0
II	2													2
IS	1							1						2
NC									5					5
NT	1								1					2
OB	6							20	2			1		29
RP														0
SI	7													7
SUG														0
Total	20	0	0	0	0	0	0	25	8	0	0	1	0	54

NY 2 Team Communications H/D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.4%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
IS	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%	0.0%	0.0%	0.0%	0.0%	9.3%
NT	1.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	0.0%	0.0%	0.0%	3.7%
OB	11.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	37.0%	3.7%	0.0%	0.0%	1.9%	0.0%	53.7%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	13.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	37.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	46.3%	14.8%	0.0%	0.0%	1.9%	0.0%	100.0%

NY 3 Team Communications R-> H/D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	2							4						6
AG	1							4						5
AS	4													4
CAR	3							1						4
CC	1							2	2					5
CL	1							2						3
COR														0
DI														0
II	1							1						2
IS	1							3						4
NC									3					3
NT									1					1
OB	1							10						11
RP														0
SI	1													1
SUG														0
Total	16	0	0	0	0	0	0	27	6	0	0	0	0	49

NY 3 Team Communications R-> H/D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%	0.0%	0.0%	0.0%	0.0%	0.0%	12.2%
AG	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%	0.0%	0.0%	0.0%	0.0%	0.0%	10.2%
AS	8.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%
CAR	6.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%
CC	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%	4.1%	0.0%	0.0%	0.0%	0.0%	10.2%
CL	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%
IS	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%	0.0%	0.0%	0.0%	0.0%	0.0%	8.2%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%	0.0%	0.0%	0.0%	0.0%	6.1%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	2.0%
OB	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.4%	0.0%	0.0%	0.0%	0.0%	0.0%	22.4%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	32.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.1%	12.2%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 3 Team Communications H/D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	2													2
AG	1							4	0					5
AS	2							2						4
CAR								1						1
CC														0
CL														0
COR														0
DI														0
II	6													6
IS	1							1						2
NC									5					5
NT									2					2
OB	2							21						23
RP								0						0
SI	5													5
SUG														0
Total	19	0	0	0	0	0	0	29	7	0	0	0	0	55

NY 3 Team Communications H/D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
AG	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
AS	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	10.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.9%
IS	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	0.0%	9.1%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%
OB	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	38.2%	0.0%	0.0%	0.0%	0.0%	0.0%	41.8%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	34.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	52.7%	12.7%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 4 Team Communications R-> H/D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC								2						2
AG														0
AS														0
CAR	1													1
CC														0
CL								1						1
COR														0
DI														0
II														0
IS								1						1
NC									1					1
NT														0
OB								2						2
RP														0
SI	5													5
SUG														0
Total	6	0	0	0	0	0	0	6	1	0	0	0	0	13

NY 4 Team Communications R-> H/D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CAR	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	7.7%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	38.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	38.5%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	46.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	46.2%	7.7%	0.0%	0.0%	0.0%	0.0%	100.0%

NY 4 Team Communications H/D -> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1													1
AG														0
AS								1			1			2
CAR								3						3
CC														0
CL														0
COR														0
DI														0
II	2							1						3
IS														0
NC									1					1
NT														0
OB								8						8
RP								1						1
SI	0							1						1
SUG														0
Total	3	0	0	0	0	0	0	15	1	0	1	0	0	20

NY 4 Team Communications H/D -> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	10.0%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.0%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	5.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	40.0%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	75.0%	5.0%	0.0%	5.0%	0.0%	0.0%	100.0%

SEA 1 Team Communications R-> H/D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC								5	1					6
AG								1						1
AS	1							2						3
CAR	2			1				1						4
CC								1						1
CL								2						2
COR														0
DI														0
II														0
IS								1						1
NC														0
NT									9					9
OB	2							10						12
RP														0
SI	2													2
SUG														0
Total	7	0	0	1	0	0	0	23	10	0	0	0	0	41

SEA 1 Team Communications R-> H/D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.2%	2.4%	0.0%	0.0%	0.0%	0.0%	14.6%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
AS	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%
CAR	4.9%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	9.8%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.0%	0.0%	0.0%	0.0%	0.0%	22.0%
OB	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	24.4%	0.0%	0.0%	0.0%	0.0%	0.0%	29.3%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	17.1%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	56.1%	24.4%	0.0%	0.0%	0.0%	0.0%	100.0%

SEA 1 Team Communications H/D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									6					6
AG								1						1
AS								3						3
CAR								4						4
CC									1					1
CL								2						2
COR														0
DI														0
II														0
IS								1						1
NC									1					1
NT									7					7
OB								12						12
RP								2						2
SI								1						1
SUG														0
Total	0	0	0	0	0	0	0	26	15	0	0	0	0	41

SEA 1 Team Communications H/D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.6%	0.0%	0.0%	0.0%	0.0%	14.6%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.8%	0.0%	0.0%	0.0%	0.0%	0.0%	9.8%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	2.4%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	2.4%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.1%	0.0%	0.0%	0.0%	0.0%	17.1%
OB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	29.3%	0.0%	0.0%	0.0%	0.0%	0.0%	29.3%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	63.4%	36.6%	0.0%	0.0%	0.0%	0.0%	100.0%

SEA 2 Team Communications R-> D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	8							16	6					30
AG	9							19						28
AS	3							10	1					14
CAR	4									1				5
CC	2							1	1					4
CL								4						4
COR	1													1
DI	1							1						2
II	1													1
IS	7							27						34
NC									3					3
NT									8					8
OB	16				1			49	1					67
RP														0
SI	14							1						15
SUG	1							1						2
Total	67	0	0	0	1	0	0	129	20	1	0	0	0	218

SEA 2 Team Communications R-> D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	3.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.3%	2.8%	0.0%	0.0%	0.0%	0.0%	13.8%
AG	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	8.7%	0.0%	0.0%	0.0%	0.0%	0.0%	12.8%
AS	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.6%	0.5%	0.0%	0.0%	0.0%	0.0%	6.4%
CAR	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	2.3%
CC	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%	1.8%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%
COR	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
DI	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
II	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
IS	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.4%	0.0%	0.0%	0.0%	0.0%	0.0%	15.6%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	1.4%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.7%	0.0%	0.0%	0.0%	0.0%	3.7%
OB	7.3%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	22.5%	0.5%	0.0%	0.0%	0.0%	0.0%	30.7%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	6.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	6.9%
SUG	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
	30.7%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	59.2%	9.2%	0.5%	0.0%	0.0%	0.0%	100.0%

SEA 2 Team Communications D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	1							1	1					3
AG	8							15						23
AS	3							15						18
CAR	5							2						7
CC								1						1
CL								6	2					8
COR	1													1
DI								1						1
II	1							1						2
IS	3							15						18
NC									4					4
NT									4					4
OB	9							61	1		1			72
RP	1													1
SI	17							1						18
SUG	7							6						13
Total	56	0	0	0	0	0	0	125	12	0	1	0	0	194

SEA 2 Team Communications D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%	1.5%
AG	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	11.9%
AS	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
CAR	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	1.0%	0.0%	0.0%	0.0%	0.0%	4.1%
COR	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
II	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
IS	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	2.1%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	0.0%	0.0%	0.0%	2.1%
OB	4.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	31.4%	0.5%	0.0%	0.5%	0.0%	0.0%	37.1%
RP	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
SI	8.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	9.3%
SUG	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%
	28.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	64.4%	6.2%	0.0%	0.5%	0.0%	0.0%	100.0%

SEA 4 Team Communications R-> D Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	3							5	2					10
AG	6							2						8
AS	4							4						8
CAR														0
OC								1	1					2
CL	1							2	1					4
COR														0
DI								1						1
II	1													1
IS	4							8						12
NC									1					1
NT									13					13
OB	19							12						31
RP														0
SI	8													8
SUG	2							0	1					3
Total	48	0	0	0	0	0	0	35	19	0	0	0	0	102

SEA 4 Team Communications R-> D Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	2.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.9%	2.0%	0.0%	0.0%	0.0%	0.0%	9.8%
AG	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%
AS	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%
CAR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	1.0%	0.0%	0.0%	0.0%	0.0%	2.0%
CL	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	1.0%	0.0%	0.0%	0.0%	0.0%	3.9%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
II	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
IS	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	1.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.7%	0.0%	0.0%	0.0%	0.0%	12.7%
OB	18.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.8%	0.0%	0.0%	0.0%	0.0%	0.0%	30.4%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	7.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.8%
SUG	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	2.9%
	47.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	34.3%	18.6%	0.0%	0.0%	0.0%	0.0%	100.0%

SEA 4 Team Communications H/D-> R Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC														0
AG	3							6				1		10
AS	1							5						6
CAR	1													1
OC	1													1
CL	1							1						2
COR	2							1						3
DI	1													1
II														0
IS	7							5						12
NC									6					6
NT									11					11
OB	9							18	2					29
RP	1							0						1
SI	5							1						6
SUG	1													1
Total	33	0	0	0	0	0	0	37	19	0	0	1	0	90

SEA 4 Team Communications H/D-> R Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AG	3.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%	1.1%	0.0%	11.1%
AS	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%
CAR	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
OC	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
CL	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	2.2%
COR	2.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	3.3%
DI	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	7.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	13.3%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	0.0%	0.0%	0.0%	6.7%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.2%	0.0%	0.0%	0.0%	0.0%	12.2%
OB	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	2.2%	0.0%	0.0%	0.0%	0.0%	32.2%
RP	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
SI	5.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%
SUG	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.1%
	36.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	41.1%	21.1%	0.0%	0.0%	1.1%	0.0%	100.0%

NY 1 Ground Air Communications - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC			1						45		33			79
AG								4						4
AS								4					1	5
CAR			37		42	34		1		17	5		10	146
CC									2					2
CL								4					1	5
COR														0
DI													1	1
II														0
IS					1	1		4			2			8
NC														0
NT														0
OB		9			2			2		11				24
RP		1												1
SI					4	2				1			2	9
SUG														0
Total	0	10	38	0	49	37	0	19	47	29	40	0	15	284

NY 1 Ground Air Communications - Frequency Percent

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	15.8%	0.0%	11.6%	0.0%	0.0%	27.8%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.4%	1.8%
CAR	0.0%	0.0%	13.0%	0.0%	14.8%	12.0%	0.0%	0.4%	0.0%	6.0%	1.8%	0.0%	3.5%	51.4%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.7%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.4%	1.8%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.0%	1.4%	0.0%	0.0%	0.7%	0.0%	0.0%	2.8%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	3.2%	0.0%	0.0%	0.7%	0.0%	0.0%	0.7%	0.0%	3.9%	0.0%	0.0%	0.0%	8.5%
RP	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
SI	0.0%	0.0%	0.0%	0.0%	1.4%	0.7%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.7%	3.2%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	3.5%	13.4%	0.0%	17.3%	13.0%	0.0%	6.7%	16.5%	10.2%	14.1%	0.0%	5.3%	100.0%

NY 2 Ground Air Communications - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC								1	59		19			79
AG								1	1					2
AS					1		1	3	1					6
CAR			25		35	15		2		16	4			97
CC									1					1
CL								2						2
COR														0
DI			1		1					1				3
II														0
IS								4						4
NC														0
NT														0
OB		13			2	2		2		10				29
RP					1	1				2				4
SI			1		3	2				1				7
SUG			1											1
Total	0	13	28	0	43	20	1	15	62	30	23	0	0	235

NY 2 Ground Air Communications - Frequency Percent

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	25.1%	0.0%	8.1%	0.0%	0.0%	33.6%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.9%
AS	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.4%	1.3%	0.4%	0.0%	0.0%	0.0%	0.0%	2.6%
CAR	0.0%	0.0%	10.6%	0.0%	14.9%	6.4%	0.0%	0.9%	0.0%	6.8%	1.7%	0.0%	0.0%	41.3%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.4%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	1.3%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	5.5%	0.0%	0.0%	0.9%	0.9%	0.0%	0.9%	0.0%	4.3%	0.0%	0.0%	0.0%	12.3%
RP	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	1.7%
SI	0.0%	0.0%	0.4%	0.0%	1.3%	0.9%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	3.0%
SUG	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
	0.0%	5.5%	11.9%	0.0%	18.3%	8.5%	0.4%	6.4%	26.4%	12.8%	9.8%	0.0%	0.0%	100.0%

NY 3 Ground Air Communications - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									12		21			33
AG														0
AS						2		2					1	5
CAR			25		27	27				9			1	89
CC			1						5					6
CL														0
COR														0
DI														0
II														0
IS								7			1			8
NC									1					1
NT														0
OB		6	1		2	3				6				18
RP					1			1		2				4
SI					3	1							1	5
SUG														0
Total	0	6	27	0	33	33	0	10	18	17	22	0	3	169

NY 3 Ground Air Communications - Frequency Percent														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%	0.0%	12.4%	0.0%	0.0%	19.5%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%	0.6%	3.0%
CAR	0.0%	0.0%	14.8%	0.0%	16.0%	16.0%	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.6%	52.7%
CC	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.6%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	0.6%	0.0%	0.0%	4.7%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.6%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	3.6%	0.6%	0.0%	1.2%	1.8%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	10.7%
RP	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.6%	0.0%	1.2%	0.0%	0.0%	0.0%	2.4%
SI	0.0%	0.0%	0.0%	0.0%	1.8%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	3.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	3.6%	16.0%	0.0%	19.5%	19.5%	0.0%	5.9%	10.7%	10.1%	13.0%	0.0%	1.8%	100.0%

NY 4 Ground Air Communication - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									42		15			57
AG														0
AS														0
CAR			20		29	8				9	4		1	71
CC									1					1
CL								1						1
COR														0
DI													1	1
II														0
IS								5						5
NC									1					1
NT														0
OB		3			6	1		2		3				15
RP						2								2
SI					1	2				0				3
SUG														0
Total	0	3	20	0	36	13	0	8	44	12	19	0	2	157

NY 4 Ground Air Communication - Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	26.8%	0.0%	9.6%	0.0%	0.0%	36.3%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CAR	0.0%	0.0%	12.7%	0.0%	18.5%	5.1%	0.0%	0.0%	0.0%	5.7%	2.5%	0.0%	0.6%	45.2%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.6%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.6%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%	0.6%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	1.9%	0.0%	0.0%	3.8%	0.6%	0.0%	1.3%	0.0%	1.9%	0.0%	0.0%	0.0%	9.6%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%
SI	0.0%	0.0%	0.0%	0.0%	0.6%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.9%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	1.9%	12.7%	0.0%	22.9%	8.3%	0.0%	5.1%	28.0%	7.6%	12.1%	0.0%	1.3%	100.0%

SEA 1 Ground Air Communications - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC						1		1	3	1	20			26
AG														0
AS														0
CAR			22		10	25		2		5	4		10	78
CC									1					1
CL													1	1
COR														0
DI														0
II														0
IS								2		1				3
NC														0
NT														0
OB									1	2				3
RP			1		1									2
SI						1				1			1	3
SUG														0
Total	0	0	23	0	11	27	0	5	5	10	24	0	12	117

SEA 1 Ground Air Communications - Frequency Percent														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.9%	2.6%	0.9%	17.1%	0.0%	0.0%	22.2%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CAR	0.0%	0.0%	18.8%	0.0%	8.5%	21.4%	0.0%	1.7%	0.0%	4.3%	3.4%	0.0%	8.5%	66.7%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.9%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.9%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.9%	0.0%	0.0%	0.0%	2.6%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	1.7%	0.0%	0.0%	0.0%	2.6%
RP	0.0%	0.0%	0.9%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.7%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.9%	2.6%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	19.7%	0.0%	9.4%	23.1%	0.0%	4.3%	4.3%	8.5%	20.5%	0.0%	10.3%	100.0%

SEA 2 Ground Air Communications - Frequency Count														
	DP	IA	IH	IP	MA	M	MO	MS	NC	RC	RH	RP	RR	
AC								5	19		23			47
AG					2			1					1	4
AS					1									1
CAR			30		56	9		2		10			6	113
CC					1			3	7					11
CL								8						8
COR														0
DI														0
II														0
IS								21		1				22
NC									1					1
NT														0
OB		4			1	1		4		6				16
RP			1		1			3		1			1	7
SI					1	1							1	3
SUG														0
Total	0	4	31	0	63	11	0	47	27	18	23	0	9	233

SEA 2 Ground Air Communications - Frequency Percent														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	8.2%	0.0%	9.9%	0.0%	0.0%	20.2%
AG	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%	1.7%
AS	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
CAR	0.0%	0.0%	12.9%	0.0%	24.0%	3.9%	0.0%	0.9%	0.0%	4.3%	0.0%	0.0%	2.6%	48.5%
CC	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	1.3%	3.0%	0.0%	0.0%	0.0%	0.0%	4.7%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.0%	0.0%	0.4%	0.0%	0.0%	0.0%	9.4%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.4%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	1.7%	0.0%	0.0%	0.4%	0.4%	0.0%	1.7%	0.0%	2.6%	0.0%	0.0%	0.0%	6.9%
RP	0.0%	0.0%	0.4%	0.0%	0.4%	0.0%	0.0%	1.3%	0.0%	0.4%	0.0%	0.0%	0.4%	3.0%
SI	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	1.3%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	1.7%	13.3%	0.0%	27.0%	4.7%	0.0%	20.2%	11.6%	7.7%	9.9%	0.0%	3.9%	100.0%

SEA 4 Ground Air Communications - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									9		12			21
AG														0
AS		1												1
CAR			13		38	15				9			3	78
CC									4					4
CL								4						4
COR														0
DI														0
II														0
IS								2			1		1	4
NC														0
NT									1					1
OB		3			2	1				5				11
RP			1			1								2
SI					2	3				1				6
SUG									1					1
Total	0	4	14	0	42	20	0	6	15	15	13	0	4	133

SEA 4 Ground Air Communications - Frequency Percent														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.8%	0.0%	9.0%	0.0%	0.0%	15.8%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%
CAR	0.0%	0.0%	9.8%	0.0%	28.6%	11.3%	0.0%	0.0%	0.0%	6.8%	0.0%	0.0%	2.3%	58.6%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.8%	0.0%	0.8%	3.0%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.8%
OB	0.0%	2.3%	0.0%	0.0%	1.5%	0.8%	0.0%	0.0%	0.0%	3.8%	0.0%	0.0%	0.0%	8.3%
RP	0.0%	0.0%	0.8%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
SI	0.0%	0.0%	0.0%	0.0%	1.5%	2.3%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	4.5%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.8%
	0.0%	3.0%	10.5%	0.0%	31.6%	15.0%	0.0%	4.5%	11.3%	11.3%	9.8%	0.0%	3.0%	100.0%

NY 1 Ground Line Communication - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									4					4
AG			1						1			4		6
AS	1								1			1		3
CAR			1	10	7	4			3	2	2		6	35
CC									12					12
CL								1						1
COR														0
DI														0
II					1					1				2
IS						1		1					1	3
NC						1			23			1		25
NT														0
OB	1							2		1		1		5
RP														0
SI	1													1
SUG														0
Total	3	0	2	10	8	6	0	4	44	4	2	7	7	97

NY 1 Ground Line Communication - Frequency Percentage														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	0.0%	0.0%	4.1%
AG	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	4.1%	0.0%	6.2%
AS	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	1.0%	0.0%	3.1%
CAR	0.0%	0.0%	1.0%	10.3%	7.2%	4.1%	0.0%	0.0%	3.1%	2.1%	2.1%	0.0%	6.2%	36.1%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.4%	0.0%	0.0%	0.0%	0.0%	12.4%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	0.0%	2.1%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	1.0%	0.0%	0.0%	0.0%	0.0%	1.0%	3.1%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	0.0%	23.7%	0.0%	0.0%	1.0%	0.0%	25.8%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%	0.0%	1.0%	0.0%	1.0%	0.0%	5.2%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	3.1%	0.0%	2.1%	10.3%	8.2%	6.2%	0.0%	4.1%	45.4%	4.1%	2.1%	7.2%	7.2%	100.0%

NY 2 Ground Line Communication - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC			1		1				1					3
AG			1		1				1					3
AS											1			1
CAR	3		2	10	4				1		5			25
CC									11					11
CL			1											1
COR														0
DI														0
II	1													1
IS	1		1		1									3
NC									17					17
NT														0
OB	1		1					1	1					4
RP														0
SI														0
SUG														0
Total	6	0	7	10	7	0	0	1	32	0	6	0	0	69

NY 2 Ground Line Communication - Frequency Percentage														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	1.4%	0.0%	1.4%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	4.3%
AG	0.0%	0.0%	1.4%	0.0%	1.4%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	4.3%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%	0.0%	0.0%	1.4%
CAR	4.3%	0.0%	2.9%	14.5%	5.8%	0.0%	0.0%	0.0%	1.4%	0.0%	7.2%	0.0%	0.0%	36.2%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.9%	0.0%	0.0%	0.0%	0.0%	15.9%
CL	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
IS	1.4%	0.0%	1.4%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.3%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	24.6%	0.0%	0.0%	0.0%	0.0%	24.6%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	1.4%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%	1.4%	1.4%	0.0%	0.0%	0.0%	0.0%	5.8%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	8.7%	0.0%	10.1%	14.5%	10.1%	0.0%	0.0%	1.4%	46.4%	0.0%	8.7%	0.0%	0.0%	100.0%

NY 3 Ground Line Communication - Frequency Count														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									3					3
AG				1							3			4
AS								1			1			2
CAR			2	7	1	2	1	1			8	1		23
CC									15					15
CL									1					1
COR														0
DI														0
II					1									1
IS								1	1		2			4
NC									10					10
NT														0
OB			2	1				1			1			5
RP														0
SI														0
SUG														0
Total	0	0	4	9	2	2	1	4	30	0	15	1	0	68

NY 3 Ground Line Communication - Frequency Percentage														
	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.4%	0.0%	0.0%	0.0%	0.0%	4.4%
AG	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.4%	0.0%	0.0%	5.9%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	1.5%	0.0%	0.0%	2.9%
CAR	0.0%	0.0%	2.9%	10.3%	1.5%	2.9%	1.5%	1.5%	0.0%	0.0%	11.8%	1.5%	0.0%	33.8%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	22.1%	0.0%	0.0%	0.0%	0.0%	22.1%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	1.5%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	1.5%	0.0%	2.9%	0.0%	0.0%	5.9%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.7%	0.0%	0.0%	0.0%	0.0%	14.7%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	0.0%	2.9%	1.5%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	1.5%	0.0%	0.0%	7.4%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	5.9%	13.2%	2.9%	2.9%	1.5%	5.9%	44.1%	0.0%	22.1%	1.5%	0.0%	100.0%

NY 4 Ground Line Communication - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									4					4
AG									1			1		2
AS									1		2			3
CAR			1	4		1					2			8
CC														0
CL											1			1
COR														0
DI														0
II									1					1
IS														0
NC									9					9
NT									1					1
OB			1					2						3
RP														0
SI								1						1
SUG														0
Total	0	0	2	4	0	1	0	3	17	0	5	1	0	33

NY 4 Ground Line Communication - Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.1%	0.0%	0.0%	0.0%	0.0%	12.1%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	3.0%	0.0%	6.1%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	6.1%	0.0%	0.0%	9.1%
CAR	0.0%	0.0%	3.0%	12.1%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	6.1%	0.0%	0.0%	24.2%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	3.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	27.3%	0.0%	0.0%	0.0%	0.0%	27.3%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
OB	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	6.1%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	6.1%	12.1%	0.0%	3.0%	0.0%	9.1%	51.5%	0.0%	15.2%	3.0%	0.0%	100.0%

SEA 1 Ground Line Communication - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC														0
AG								2	0			1		3
AS														0
CAR			1	2		2			0			1	1	7
CC									1					1
CL														0
COR														0
DI														0
II														0
IS														0
NC									2					2
NT														0
OB				2	1			1	0		1		1	6
RP		0	0											0
SI												0		0
SUG														0
Total	0	0	1	4	1	2	0	3	3	0	1	2	2	19

SEA 1 Ground Line Communication - Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.5%	0.0%	0.0%	0.0%	5.3%	0.0%	15.8%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
CAR	0.0%	0.0%	5.3%	10.5%	0.0%	10.5%	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	5.3%	36.8%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%	0.0%	5.3%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.5%	0.0%	0.0%	0.0%	0.0%	10.5%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	0.0%	0.0%	0.0%	10.5%	5.3%	0.0%	0.0%	5.3%	0.0%	0.0%	5.3%	0.0%	5.3%	31.6%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	5.3%	21.1%	5.3%	10.5%	0.0%	15.8%	15.8%	0.0%	5.3%	10.5%	10.5%	100.0%

SEA 2 Ground Line Communication - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									4					4
AG								2		1		3		6
AS													1	1
CAR			1	6				3		2	4		1	17
CC									1					1
CL								2		1				3
COR														0
DI								1						1
II														0
IS			1	1	1			6						9
NC			1						10					11
NT														0
OB	1		1	1				17	1		1	0		22
RP														0
SI	3				1									4
SUG	1													1
Total	5	0	4	8	2	0	0	31	16	4	5	3	2	80

SEA 2 Ground Line Communication - Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%	0.0%	0.0%	0.0%	0.0%	5.0%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.0%	1.3%	0.0%	3.8%	0.0%	7.5%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	1.3%
CAR	0.0%	0.0%	1.3%	7.5%	0.0%	0.0%	0.0%	3.8%	0.0%	2.5%	5.0%	0.0%	1.3%	21.3%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	1.3%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%	0.0%	1.3%	0.0%	0.0%	0.0%	3.8%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	1.3%	1.3%	1.3%	0.0%	0.0%	7.5%	0.0%	0.0%	0.0%	0.0%	0.0%	11.3%
NC	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	13.8%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OB	1.3%	0.0%	1.3%	1.3%	0.0%	0.0%	0.0%	21.3%	1.3%	0.0%	1.3%	0.0%	0.0%	27.5%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	3.8%	0.0%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	5.0%
SUG	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%
	6.3%	0.0%	5.0%	10.0%	2.5%	0.0%	0.0%	38.8%	20.0%	5.0%	6.3%	3.8%	2.5%	100.0%

SEA 4 Ground Line Communication - Frequency Count

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC									1					1
AG														0
AS								1						1
CAR			1	3										4
CC								1						1
CL														0
COR														0
DI									1					1
II														0
IS								2	1					3
NC									1					1
NT									8					8
OB	1			1		1		4	1			1		9
RP														0
SI	1			1	1			1						4
SUG														0
Total	2	0	1	5	1	1	0	9	13	0	0	1	0	33

SEA 4 Ground Line Communication - Frequency Percentage

	DP	IA	IH	IP	MA	MD	MO	MS	NC	RC	RH	RP	RR	
AC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
AG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
AS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
CAR	0.0%	0.0%	3.0%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.1%
CC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%
CL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
COR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
DI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
II	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.1%	3.0%	0.0%	0.0%	0.0%	0.0%	9.1%
NC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	3.0%
NT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	24.2%	0.0%	0.0%	0.0%	0.0%	24.2%
OB	3.0%	0.0%	0.0%	3.0%	0.0%	3.0%	0.0%	12.1%	3.0%	0.0%	0.0%	3.0%	0.0%	27.3%
RP	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SI	3.0%	0.0%	0.0%	3.0%	3.0%	0.0%	0.0%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.1%
SUG	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	6.1%	0.0%	3.0%	15.2%	3.0%	3.0%	0.0%	27.3%	39.4%	0.0%	0.0%	3.0%	0.0%	100.0%

E-3.0 ANOVA's and Correlations User Information

ANOVA's

This section contains the following sets of ANOVA's:

Team Communication for Radar Associate
Team Communication Categories
Team Task Categories

Ground-Air Communication Categories
Ground-Air Task Categories

Ground-Line Communication Categories
Ground-Line Task Categories

Within each of the above sets, the ANOVA tables are reported in the following order:

Acknowledgment
Agreement
Answer Supplying Info.
Command/Request Action
Courtesy Comment
Clarify Response Comment
Correcting Response
Disagreement
Inquiry - Intent
Inquiry - Situation
Noncodable
Non-Task Related
Observation
Repetition
Statement of Intent
Suggestion

Correlations

The Ground-Line Communication correlations are reported at the end of this section. The legends at the bottom of each page provide an explanation of the abbreviated variable names.

ANOVA's: Team Communication for Radar Associate

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.704E-4	2.704E-4	.104	.7605
Residual	5	.013	.003		

Dependent: Acknowledgment

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.006	.006	2.493	.1752
Residual	5	.011	.002		

Dependent: Agreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.649E-4	1.649E-4	1.055	.3514
Residual	5	.001	1.563E-4		

Dependent: Answer

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.520E-6	1.520E-6	4.158E-4	.9845
Residual	5	.018	.004		

Dependent: Command/Request

ANOVA's: Team Communication for Radar Associate

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.155E-4	3.155E-4	8.155	.0356
Residual	5	1.934E-4	3.869E-5		

Dependent: Courtesy Comment

Means Table
Effect: CENTER
Dependent: Courtesy Comment

	Count	Mean	Std. Dev.	Std. Error
NY	4	0.000	0.000	0.000
SEA	3	.014	.010	.006

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	22.626	.0051
Residual	5	4.581E-4	9.163E-5		

Dependent: Clarify Response

Means Table
Effect: CENTER
Dependent: Clarify Response

	Count	Mean	Std. Dev.	Std. Error
NY	4	.003	.005	.003
SEA	3	.037	.014	.008

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.823E-4	2.823E-4	2.199	.1982
Residual	5	.001	1.284E-4		

Dependent: Correcting Response

ANOVA's: Team Communication for Radar Associate

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.352E-5	1.352E-5	.468	.5242
Residual	5	1.444E-4	2.887E-5		

Dependent: Disagreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.010	.010	4.431	.0892
Residual	5	.011	.002		

Dependent: Inquiry-Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.003	.003	1.384	.2924
Residual	5	.011	.002		

Dependent: Inquiry-Situation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.007	.007	3.975	.1028
Residual	5	.009	.002		

Dependent: Noncodable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.010	.010	3.810	.1084
Residual	5	.013	.003		

Dependent: Non-Task-Related

ANOVA's: Team Communication for Radar Associate

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.025	.025	8.740	.0316
Residual	5	.014	.003		

Dependent: Observation

Means Table
Effect: CENTER
Dependent: Observation

	Count	Mean	Std. Dev.	Std. Error
NY	4	.449	.061	.030
SEA	3	.329	.040	.023

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	7.411E-5	7.411E-5	.132	.7315
Residual	5	.003	.001		

Dependent: Repetition

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.469E-4	3.469E-4	.213	.6635
Residual	5	.008	.002		

Dependent: Statement of Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	2.252	.1937
Residual	5	.003	.001		

Dependent: Suggestion

ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.129	.7269
POSITION	1	.033	.033	8.314	.0163
CENTER * POSIT...	1	.002	.002	.523	.4861
Residual	10	.040	.004		

Dependent: Acknowledgment

Means Table
Effect: POSITION
Dependent: Acknowledgment

	Count	Mean	Std. Dev.	Std. Error
R-SIDE	7	.148	.070	.026
D/H-SIDE	7	.047	.047	.018

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.004	.004	1.628	.2308
POSITION	1	.001	.001	.364	.5597
CENTER * POSIT...	1	.002	.002	.832	.3830
Residual	10	.023	.002		

Dependent: Agreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.700E-4	1.700E-4	.384	.5494
POSITION	1	.002	.002	4.051	.0719
CENTER * POSIT...	1	.001	.001	2.204	.1684
Residual	10	.004	4.429E-4		

Dependent: Answer

ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	.734	.4116
POSITION	1	.001	.001	.360	.5621
CENTER * POSIT...	1	.002	.002	.805	.3907
Residual	10	.025	.002		

Dependent: Command/Request

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	9.054E-6	9.054E-6	.012	.9134
POSITION	1	.001	.001	1.710	.2203
CENTER * POSIT...	1	4.700E-4	4.700E-4	.646	.4401
Residual	10	.007	.001		

Dependent: Courtesy Comment

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	1.760	.2141
POSITION	1	.001	.001	1.742	.2163
CENTER * POSIT...	1	.001	.001	2.197	.1691
Residual	10	.005	.001		

Dependent: Clarify Response

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.761E-4	1.761E-4	2.712	.1306
POSITION	1	1.037E-4	1.037E-4	1.597	.2350
CENTER * POSIT...	1	1.037E-4	1.037E-4	1.597	.2350
Residual	10	.001	6.493E-5		

Dependent: Correcting Response

ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.260E-5	3.260E-5	1.076	.3240
POSITION	1	8.571E-7	8.571E-7	.028	.8697
CENTER * POSIT...	1	8.571E-7	8.571E-7	.028	.8697
Residual	10	3.028E-4	3.028E-5		

Dependent: Disagreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.006	.006	4.903	.0512
POSITION	1	.004	.004	2.904	.1192
CENTER * POSIT...	1	.004	.004	3.211	.1034
Residual	10	.012	.001		

Dependent: Inquiry-Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.003	.003	1.358	.2709
POSITION	1	.003	.003	1.448	.2566
CENTER * POSIT...	1	.001	.001	.294	.5995
Residual	10	.020	.002		

Dependent: Inquiry-Situation

ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.015	.015	16.086	.0025
POSITION	1	.002	.002	2.571	.1400
CENTER * POSIT...	1	2.917E-5	2.917E-5	.031	.8630
Residual	10	.009	.001		

Dependent: Noncodable

Means Table
Effect: CENTER
Dependent: Noncodable

	Count	Mean	Std. Dev.	Std. Error
NY	8	.089	.036	.013
SEA	6	.023	.023	.010

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.020	.020	5.154	.0466
POSITION	1	.002	.002	.505	.4934
CENTER * POSIT...	1	3.810E-7	3.810E-7	1E-4	.9922
Residual	10	.038	.004		

Dependent: Non-Task-Related

Means Table
Effect: CENTER
Dependent: Non-Task-Related

	Count	Mean	Std. Dev.	Std. Error
NY	8	.041	.039	.014
SEA	6	.116	.077	.031

ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.357	.5637
POSITION	1	.060	.060	24.668	.0006
CENTER * POSIT...	1	.038	.038	15.512	.0028
Residual	10	.024	.002		

Dependent: Observation

Means Table
Effect: POSITION
Dependent: Observation

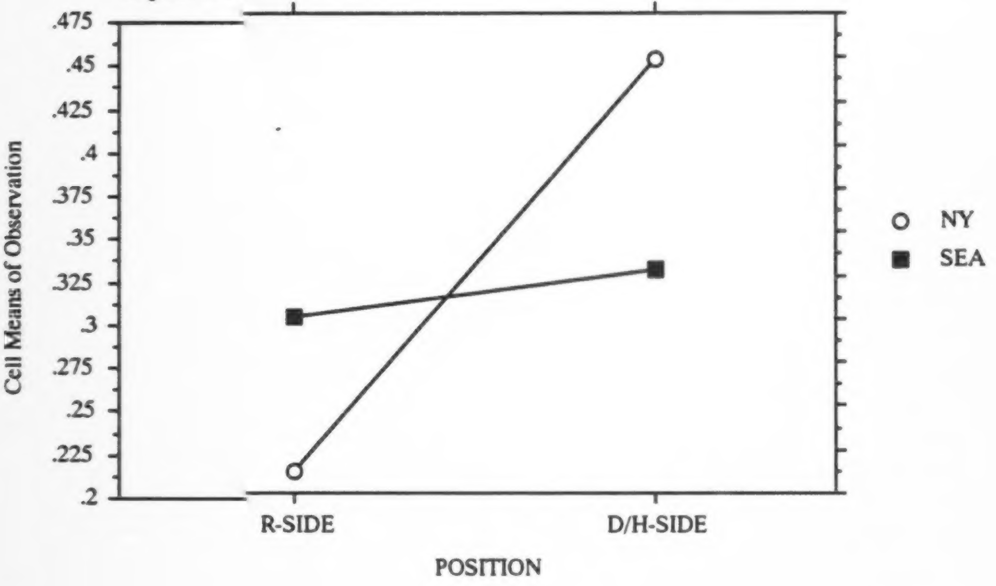
	Count	Mean	Std. Dev.	Std. Error
R-SIDE	7	.251	.063	.024
D/H-SIDE	7	.398	.081	.031

ANOVA's: Team Communication Categories

Means Table
Effect: CENTER * POSITION
Dependent: Observation

	Count	Mean	Std. Dev.	Std. Error
NY, R-SIDE	4	.212	.057	.029
NY, D/H-SIDE	4	.449	.061	.030
SEA, R-SIDE	3	.301	.007	.004
SEA, D/H-SIDE	3	.329	.039	.023

Interaction Plot
Effect: CENTER * POSITION
Dependent: Observation



ANOVA's: Team Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.529E-5	3.529E-5	.125	.7313
POSITION	1	.001	.001	4.129	.0696
CENTER * POSIT...	1	3.529E-5	3.529E-5	.125	.7313
Residual	10	.003	2.829E-4		

Dependent: Repetition

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.004	.004	.446	.5195
POSITION	1	.002	.002	.226	.6448
CENTER * POSIT...	1	.002	.002	.161	.6965
Residual	10	.101	.010		

Dependent: Statement of Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	4.240	.0665
POSITION	1	1.524E-4	1.524E-4	.504	.4939
CENTER * POSIT...	1	1.524E-4	1.524E-4	.504	.4939
Residual	10	.003	3.023E-4		

Dependent: Suggestion

ANOVA's: Team Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.003	.003	.155	.7019
POSITION	1	.037	.037	1.838	.2051
CENTER * POSIT...	1	1.412E-4	1.412E-4	.007	.9350
Residual	10	.202	.020		

Dependent: Develop Plan

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
POSITION	1	0.000	0.000	•	•
CENTER * POSIT...	1	0.000	0.000	•	•
Residual	10	0.000	0.000		

Dependent: Issue Advisory

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
POSITION	1	0.000	0.000	•	•
CENTER * POSIT...	1	0.000	0.000	•	•
Residual	10	0.000	0.000		

Dependent: Initiate Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	5.486E-5	5.486E-5	1.429	.2596
POSITION	1	5.486E-5	5.486E-5	1.429	.2596
CENTER * POSIT...	1	5.486E-5	5.486E-5	1.429	.2596
Residual	10	3.840E-4	3.840E-5		

Dependent: Initiate Pointout

ANOVA's: Team Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.381E-6	2.381E-6	1.429	.2596
POSITION	1	2.381E-6	2.381E-6	1.429	.2596
CENTER * POSIT...	1	2.381E-6	2.381E-6	1.429	.2596
Residual	10	1.667E-5	1.667E-6		

Dependent: Manage Arrivals

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	6.482E-6	6.482E-6	.714	.4178
POSITION	1	6.482E-6	6.482E-6	.714	.4178
CENTER * POSIT...	1	6.482E-6	6.482E-6	.714	.4178
Residual	10	9.075E-5	9.075E-6		

Dependent: Manage Departures

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
POSITION	1	0.000	0.000	•	•
CENTER * POSIT...	1	0.000	0.000	•	•
Residual	10	0.000	0.000		

Dependent: Manage Overflights

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.204E-4	3.204E-4	.024	.8795
POSITION	1	.028	.028	2.091	.1788
CENTER * POSIT...	1	.002	.002	.169	.6894
Residual	10	.133	.013		

Dependent: Maintain Sit. Awareness

ANOVA's: Team Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.006	.006	.631	.4455
POSITION	1	3.013E-4	3.013E-4	.032	.8616
CENTER * POSIT…	1	.003	.003	.319	.5844
Residual	10	.094	.009		

Dependent: Noncodable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.381E-6	2.381E-6	1.429	.2596
POSITION	1	2.381E-6	2.381E-6	1.429	.2596
CENTER * POSIT…	1	2.381E-6	2.381E-6	1.429	.2596
Residual	10	1.667E-5	1.667E-6		

Dependent: Resolve Conflict

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.006E-4	1.006E-4	.532	.4826
POSITION	1	1.720E-4	1.720E-4	.909	.3628
CENTER * POSIT…	1	1.006E-4	1.006E-4	.532	.4826
Residual	10	.002	1.892E-4		

Dependent: Receive Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.006E-6	1.006E-6	.029	.8690
POSITION	1	6.072E-5	6.072E-5	1.728	.2180
CENTER * POSIT…	1	1.006E-6	1.006E-6	.029	.8690
Residual	10	3.514E-4	3.514E-5		

Dependent: Receive Pointout

ANOVA's: Team Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
POSITION	1	0.000	0.000	•	•
CENTER * POSIT…	1	0.000	0.000	•	•
Residual	10	0.000	0.000		

Dependent: Reroute Aircraft

ANOVA's: Ground-Air Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.017	.017	4.487	.0877
Residual	5	.019	.004		

Dependent: Acknowledgment

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.190E-8	1.190E-8	1.764E-4	.9899
Residual	5	3.374E-4	6.748E-5		

Dependent: Agreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.604E-4	3.604E-4	3.201	.1336
Residual	5	.001	1.126E-4		

Dependent: Answer

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.018	.018	3.594	.1165
Residual	5	.025	.005		

Dependent: Command/Request

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.074E-4	4.074E-4	1.435	.2846
Residual	5	.001	2.839E-4		

Dependent: Courtesy Comment

ANOVA's: Ground-Air Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.434E-4	4.434E-4	4.188	.0961
Residual	5	.001	1.059E-4		

Dependent: Clarify Response

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Correcting Response

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	5.668E-5	5.668E-5	3.193	.1340
Residual	5	8.875E-5	1.775E-5		

Dependent: Disagreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Inquiry-Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.917	.3822
Residual	5	.003	.001		

Dependent: Inquiry-Situation

ANOVA's: Ground-Air Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.762E-6	4.762E-6	.510	.5070
Residual	5	4.667E-5	9.333E-6		

Dependent: Noncodable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.219E-5	1.219E-5	1.429	.2856
Residual	5	4.267E-5	8.533E-6		

Dependent: Non-Task-Related

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.003	.003	6.328	.0535
Residual	5	.003	.001		

Dependent: Observation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	6.519E-5	6.519E-5	.954	.3736
Residual	5	3.417E-4	6.833E-5		

Dependent: Repetition

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.071E-7	1.071E-7	.001	.9777
Residual	5	.001	1.245E-4		

Dependent: Statement of Intent

ANOVA's: Ground-Air Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.762E-6	4.762E-6	.436	.5385
Residual	5	5.467E-5	1.093E-5		

Dependent: Suggestion

ANOVA's: Ground-Air Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Develop Plan

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	3.291	.1294
Residual	5	.001	2.207E-4		

Dependent: Issue Advisory

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.714E-4	1.714E-4	.159	.7066
Residual	5	.005	.001		

Dependent: Initiate Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Initiate Pointout

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	.294	.6110
Residual	5	.029	.006		

Dependent: Manage Arrivals

ANOVA's: Ground-Air Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.128	.7353
Residual	5	.025	.005		

Dependent: Manage Departures

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.714E-6	1.714E-6	.714	.4366
Residual	5	1.200E-5	2.400E-6		

Dependent: Manage Overflights

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	.677	.4481
Residual	5	.017	.003		

Dependent: Maintain Sit. Awareness

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.022	.022	4.642	.0838
Residual	5	.024	.005		

Dependent: Non-Codeable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	1.743E-4	1.743E-4	.422	.5448
Residual	5	.002	4.135E-4		

Dependent: Resolve Conflict

ANOVA's: Ground-Air Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.267E-4	2.267E-4	.132	.7309
Residual	5	.009	.002		

Dependent: Receive Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Receive Pointout

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	2.404	.1817
Residual	5	.005	.001		

Dependent: Reroute Aircraft

ANOVA's: Ground-Line Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	1.848	.2321
Residual	5	.006	.001		

Dependent: Acknowledgment

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.309	.6024
Residual	5	.013	.003		

Dependent: Agreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	1.582	.2640
Residual	5	.004	.001		

Dependent: Answer

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.014	.014	1.765	.2414
Residual	5	.041	.008		

Dependent: Command/Request

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.015	.015	2.826	.1536
Residual	5	.027	.005		

Dependent: Courtesy Comment

ANOVA's: Ground-Line Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.601E-5	3.601E-5	.151	.7137
Residual	5	.001	2.387E-4		

Dependent: Clarify Response

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Correcting Response

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.522E-4	3.522E-4	3.890	.1056
Residual	5	4.527E-4	9.053E-5		

Dependent: Disagreement

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	21.164	.0058
Residual	5	1.620E-4	3.240E-5		

Dependent: Inquiry-Intent

Means Table
Effect: CENTER
Dependent: Inquiry-Intent

	Count	Mean	Std. Dev.	Std. Error
NY	4	.020	.007	.004
SEA	3	0.000	0.000	0.000

ANOVA's: Ground-Line Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.002	.002	1.144	.3337
Residual	5	.009	.002		

Dependent: Inquiry-Situation

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.034	.034	10.566	.0227
Residual	5	.016	.003		

Dependent: Noncodable

Means Table
Effect: CENTER
Dependent: Noncodable

	Count	Mean	Std. Dev.	Std. Error
NY	4	.231	.057	.029
SEA	3	.091	.055	.032

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.009	.009	1.155	.3316
Residual	5	.040	.008		

Dependent: Non-Task-Related

ANOVA's: Ground-Line Communication Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.082	.082	196.511	.0001
Residual	5	.002	4.193E-4		

Dependent: Observation

Means Table
Effect: CENTER
Dependent: Observation

	Count	Mean	Std. Dev.	Std. Error
NY	4	.069	.018	.009
SEA	3	.288	.024	.014

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Repetition

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.004	.004	2.369	.1844
Residual	5	.008	.002		

Dependent: Statement of Intent

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.219E-5	3.219E-5	1.429	.2856
Residual	5	1.127E-4	2.253E-5		

Dependent: Suggestion

ANOVA's: Ground-Line Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.400E-4	2.400E-4	.158	.7077
Residual	5	.008	.002		

Dependent: Develop Plan

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	0.000	0.000	•	•
Residual	5	0.000	0.000		

Dependent: Issue Advisory

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.480E-4	4.480E-4	.637	.4609
Residual	5	.004	.001		

Dependent: Initiate Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	1.019	.3592
Residual	5	.007	.001		

Dependent: Initiate Pointout

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	4.954E-4	4.954E-4	.355	.5772
Residual	5	.007	.001		

Dependent: Manage Arrivals

ANOVA's: Ground-Line Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	3.730E-4	3.730E-4	.240	.6450
Residual	5	.008	.002		

Dependent: Manage Departures

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	2.411E-5	2.411E-5	.714	.4366
Residual	5	1.688E-4	3.375E-5		

Dependent: Manage Overflights

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.084	.084	14.248	.0130
Residual	5	.030	.006		

Dependent: Maintain Sit. Awareness

Means Table
Effect: CENTER
Dependent: Maintain Sit. Awareness

	Count	Mean	Std. Dev.	Std. Error
NY	4	.051	.032	.016
SEA	3	.273	.115	.066

ANOVA's: Ground-Line Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.081	.081	11.672	.0189
Residual	5	.035	.007		

Dependent: Noncodable

Means Table
Effect: CENTER
Dependent: Noncodable

	Count	Mean	Std. Dev.	Std. Error
NY	4	.468	.032	.016
SEA	3	.251	.126	.073

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	7.058E-5	7.058E-5	.121	.7426
Residual	5	.003	.001		

Dependent: Resolve Conflict

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.011	.011	2.337	.1868
Residual	5	.024	.005		

Dependent: Receive Handoff

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	1.102	.3418
Residual	5	.006	.001		

Dependent: Receive Pointout

ANOVA's: Ground-Line Task Categories

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
CENTER	1	.001	.001	.555	.4897
Residual	5	.010	.002		

Dependent: Reroute Aircraft

Ground-Line Communication Correlations

Correlation Matrix for Variables: $X_1 \ldots X_8$

	YRS-FPL	VOLUME	COMPLEX	ACKNOW	AGREE	ANSWER	COMM	COURT
YRS-FPL	1							
VOLUME	.5	1						
COMPLEX	.15	.61	1					
ACKNOW	.59	.57	.25	1				
AGREE	.35	-.25	-.1	-.33	1			
ANSWER	.57	.34	-.1	.92	-.35	1		
COMM	.56	.24	.29	-.26	.57	-.3	1	
COURT	.11	.08	.41	-.27	-.1	-.28	.64	1

Correlation Matrix for Variables: $X_1 \ldots X_8$

	YRS-FPL	VOLUME	COMPLEX	CLARIFY	CORR	DISAGRE	INQ-INT	INQ-SIT
YRS-FPL	1							
VOLUME	.5	1						
COMPLEX	.15	.61	1					
CLARIFY	.29	.54	.7	1				
CORR	•	•	•	•	1			
DISAGRE	-.85	-.42	-.39	-.19	•	1		
INQ-INT	.83	.65	.23	.32	•	-.59	1	
INQ-SIT	-.83	-.15	.34	.24	•	.7	-.56	1

YRS-FPL	Years of FPL Experience
VOLUME	Traffic Volume Rating
COMPLEX	Traffic Complexity Rating
ACKNOW	Acknowledgment
AGREE	Agreement
ANSWER	Answer Supplying Information
COMM	Command/Request Action
COURT	Courtesy Comment
CLARIFY	Clarify Response Comment
CORR	Correcting Response
DISAGRE	Disagreement
INQ-INT	Inquiry-Intent
INQ-SIT	Inquiry-Situation

Note: To be statistically significant at the $p < .05$ level, a correlation must be .754 or higher.

Ground-Line Communication Correlations

Correlation Matrix for Variables: $X_1 \ldots X_8$

	YRS-FPL	VOLUME	COMPLEX	NONCOD	NONTASK	OBSERV	REPET	STATE
YRS-FPL	1							
VOLUME	.5	1						
COMPLEX	.15	.61	1					
NONCOD	.82	.88	.49	1				
NONTASK	-.63	-.43	-.64	-.63	1			
OBSERV	-.6	-.68	-.48	-.8	.38	1		
REPET	•	•	•	•	•	•	1	
STATE	-.7	-.33	-.44	-.61	.92	.5	•	1

Correlation Matrix for Variables: $X_1 \ldots X_5$

	YRS-FPL	VOLUME	COMPLEX	RATIO	SUGGEST
YRS-FPL	1				
VOLUME	.5	1			
COMPLEX	.15	.61	1		
RATIO	-.77	-.21	-.34	1	
SUGGEST	-.38	.09	.53	-.08	1

YRS-FPL	Years of FPL Experience
VOLUME	Traffic Volume Rating
COMPLEX	Traffic Complexity Rating
NONCOD	Noncodable
NONTASK	Non-Task-Related
OBSERV	Observation
REPET	Repetition
STATE	Statement of Intent
SUGGEST	Suggestion
RATIO	Mean Ratio of OB/DP to OB/MS

Note: To be statistically significant at the $p < .05$ level, a correlation must be .754 or higher.